Investigation of the Occurrence and Behavior Patterns of Whales in the Vicinity of the Beaufort Sea Lease Area

FINAL REPORT FOR THE
PERIOD SEPTEMBER 1-30, 1978

Proposed for:
U.S. Department of Interior
Bureau of Land Management
Alaska OCS Office
Anchorage, Alaska

NAVAL ARCTIC RESEARCH LABORATORY

Barrow, Alaska

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INTRODUCTION

This report provides results on research accomplished by the PROJECT WHALES research team through 30 September 1978. The report discusses the activities of each project by research units (RU's). Data, which may be significant to the immediate needs of the Bureau of Land Management, are included. Other data, such as bibliographical material, maps and sonograms are archived at the NARL and are available upon request.

PROJECT WHALES commenced in late August, 1978, to take advantage of the fall bowhead (*Balaena mysticetus*) and gray (*Eschrichtius robustus*) whale migration through the Beaufort Sea Lease Area. During this period, extensive consultation was accomplished between the PROJECT WHALES research team and the BLM/OCS office in Anchorage to determine, the best plan of research in response to the Work Statement.

INVESTIGATOR

Ray B. Dronenburg, B.S.

STATEMENT OF TASK

Determine the presence or absence of endangered whales in or near the proposed Federal/State Beaufort Sea Lease Area.

PURPOSE

The following objectives are in direct support of the work statement.

1. Initiate and carry out a limited field program to develop the equipment and procedures for determining the presence or absence of whales in the proposed Beaufort Sea Lease Area using bioacoustics techniques.
2. As feasible, in the short period available, attempt to record whale vocalizations in a field environment.
3. Validate recorded vocalizations by visual and, if possible, photographic means.

Due to an almost complete lack of base line vocalization data, episodic events are utilized wherever encountered.

SCOPE

Sonobuoys were used as sensing devices and monitored from aircraft and a land-based camp at Pingok Island, Acoustical survey of the proposed lease area was emphasized.

MATERIALS AND METHODS

To accomplish the objectives two complimentary approaches were used. The primary method was to utilize bottom-anchored, floating-platform sonobuoys that received and transmitted. They were monitored from a fixed shore base site. The other method was an air survey over the lease area using air-deployable sonobuoys for contacts-of-opportunity with endangered whales.

Sonobuoys were used as the primary sensing device for the following reasons:

1. Transfer of data to the observer via long-range telemetry enhanced the safety of the observer and did not disturb the whale..
2. Durability, relatively inexpensive and easily transportable.
3. Flat frequency response over a frequency band known to include some, if not all, of the whale's vocalizations.
4. Usable from shore base and aircraft.

The shore base site at Pingok Island was selected because a camp was already in existence and it was convenient to the proposed lease area. Aircraft overflights were scheduled to compliment Pingok Island capability by extending the survey area to the entire lease area.

On 14 September 1978, two field technicians were flown to Oliktok DEW Line Station, from which they transported, via inflatable boat, gear needed to set up a field camp at Pingok Island. Three wannigans were already located on the island, This location proved to be ideal as a base camp from which the field work was initiated.

The following day supplies and equipment from the Naval Arctic Research Laboratory were air-dropped. The first three days were spent retrieving and organizing the air-dropped gear. On 18 September, the lead technical engineer arrived bringing acoustical equipment needed for the study.

RESULTS

The first stationary sonobuoy was placed in 12 ft of water in Simpson Lagoon on 21 September. The lagoon at this time was completely ice-free. Large chunks of multi-year ice continued to pile up on the ocean beach, making it impossible to get a vessel out to a depth where a sonobuoy would be effective. Transmission and reception from the sonobuoy was excellent. Although the battery package used with this particular sonobuoy lasted 12 hours, only 'water sounds' were heard. Constant monitoring revealed no mammal vocalizations in this particular area from this date until the camp was closed.

On 23 September, three sonobuoys were air-dropped. One was deployed beyond- the receiving range of the antenna being used. A second was dropped and destroyed when it landed on the ice. The third sonobuoy, dropped 4 miles north of the camp, transmitted well. Although a ringed seal was spotted along shore, no mammal vocalizations were heard. Instead, very clear ice and water sounds were received. Later the same day ice conditions along the beach had loosened enough for boat navigation. A stationary sonobuoy was placed 1/4 mile north of the island in 30 ft of water, Transducer signal was weak but of sufficient quality to distinguish sounds. No mammal sounds were identified.

The following day, 24 September, found the previously placed stationary sonobuoy 200 yards out of position and surrounded by ice. A boston whaler was used in an attempt to recover the ice-fast sonobuoy. It *was* eventually retrieved with great difficulty.

On 25 September, two sonobuoys were air dropped 1 mile north and 1-1/4 miles northwest of the cabins. Signals from both were clear and received well.

Two sonobuoys were deployed on 26 September 3/4 miles north and 1-1/2 *miles* west and 1-1/3 miles north and 1-1/2 miles west, respectively. Reception from both was weak, probably due to limited antenna range; however, no animal sounds were heard. An attempt to extend the antenna capabilities with helium-filled weather balloons, proved to be unsuccessful. Strong winds prevented the 8 balloons from elevating the antenna to a better receiving altitude.

On 27 September, two sonobuoys were dropped 5 miles north and 16 miles north and monitored at elevations of 4,500 feet and 12,500 feet, respectively. The receiver and recorder used to track the sounds were taken in the aircraft to insure good reception. Both sonobuoys transmitted well and an unidentified mammal was heard until FM radio interference from the Oliktok DEW Line Station prevented reception.

On 29 September, a 50-ft aluminum pole with receiving antenna was set up to enhance reception from distant mobile sonobuoys. One sonobuoy was dropped to test the capabilities of the new antenna. Reception was not good. Ice conditions remained severe enough on the ocean side of Pingok Island to limit boat travel. The stationary buoy on the lagoon side did not reveal any animal activity, and ice began to form in less disturbed portions of the lagoon.

On 1 October, boat travel was impossible anywhere near Pingok Island. Semi-solid ice extended out 100 yards on the oceanside, and new 2-inch thick ice formed in Simpson Lagoon. The battery pack on the stationary sonobuoy in the lagoon expired. The sonobuoy was retrieved when the ice was thick enough for safe snow machine travel.

On 2 October recordings were made that were similar to previous recordings of the bowhead whale. An air-dropped sonobuoy was deployed 3/4 miles north of the camp. The sounds appeared to indicate the presence of whales as well as a great number of bearded and ringed seals. It is noteworthy that the first indication of marine mammal activity occurred as the multi-year ice moved close to the island. Also, vocalizations were not heard until after the grounded ice had been ‘cemented’ in by a margin of semi-solid ice that formed along the length of Pingok Island.

By the following day the young ice along the north coast of the island hardened up enough to hold the weight of a person. A stationary sonobuoy was positioned 100 yds out on the ice in 15 ft of water. Ringed and bearded seal vocalizations were heard for the duration of the sonobuoy's life. No whale sounds were heard.

On 5 October, it was decided to discontinue the effort at Pingok Island, and to begin camp closure. Because of weather deterioration, placing sonobuoys was no longer feasible for the results that were being obtained. The stationary sonobuoys placed along the shore-fast ice were only sensing ice sounds and small marine mammal activity in that area. However, it appeared that the water depth was sufficient to allow bowhead whales to pass within range of the sonobuoy. Sonobuoys air-dropped in the ice-free water would not have been within range of the receiving antenna on shore, and static interference would have prevented recording from an airplane. October 7 was the last day spent on the island.

In summary, approximately 10 flights were flown during the observation period and some 25 sonobuoys were dropped. Results included five tapes with some sounds similar to those recognized as whale vocalizations. These tapes were provided to the Naval Ocean System Command for analyses. Results of this analysis are included in Appendix A.

A record of ice conditions in the lagoon and on the ocean side of Pingok Island, as well as records of water and air temperatures, wind velocity and visibility are included in Appendix B. These represent the period 14 September through 6 October which corresponds with the period of field camp occupation.

ABSTRACT

The primary objective of the bioacoustics program was to initiate and conduct a limited field program to develop the equipment and procedures for determining the presence or absence of endangered whales in the proposed Beaufort Sea Lease Area. During a 3-week period from 14 September through 5 October, 1978, a shore camp was established at Pingok Island and modified recoverable sonobuoys were deployed at various times and locations. In addition, approximately 10 flights were made over the lease area. Although a number of recordings of potential whale vocalizations were made, analysis revealed that only one recording was of a bowhead whale. However, this validated recording was made at a distance of 100 miles from the lease area and in an area of greatly dissimilar bathymetry. Techniques for sonobuoy deployment in a marginal ice environment were developed, and a large number of recordings of somniferous marine fauna other than cetacea were made and archived.

INVESTIGATOR

Arnie M. Hanson, Ph.D. Candidate

PURPOSE

To assess ice extent, type and concentration along the fall and spring migration routes of bowhead and gray whales and to determine the possible effects of the ice on the migration of these whales especially in and around the proposed Federal/State Beaufort Sea Lease Area.

RESULTS

Only a proposal was written for PROJECT WHALES. However, two ice reconnaissance flights were carried out for another project and these established that a 50-100 mile wide band of open water from the eastern Beaufort Sea to Point Barrow existed through September.

INVESTIGATOR

Erich H. Follmann, Ph.D.

STATEMENT OF TASK

Whales will be tagged with radio-transmitters to follow their movements in the Beaufort Sea, with special emphasis on the waters in and around the proposed Federal/State Beaufort Sea Lease Area.

PURPOSE

The project has two main objectives: to study the movements and distribution of whales in the Beaufort Sea, and to assess the suitability of using radio-telemetry equipment to track whales in the Beaufort Sea. Interest in whether whales utilize the waters in and around the proposed Beaufort Sea Lease Area forms the major impetus for the study. Specific objectives are:

1. Tag up to six gray whales at Point Barrow.
2. Delineate summer use areas of tagged gray whales in the Arctic Ocean.
3. Describe movement routes and durations of tagged gray whales from Point Barrow.
4. Determine the life expectancy of a small radio-tag attached to whales in the Beaufort Sea.

Objectives (l), (2) and (3) address Item 1 of the Work Statement. However, Objective (4) must be answered simultaneously or at least first to determine the suitability of a new radio-tag device for use in arctic waters. The tag built by Ocean Applied Research (OAR) has achieved a maximum of less than 21 days on a whale and that life expectancy was not considered cost-effective for use in arctic waters. A new design using a well proven radio-transmitter will be used, therefore. This transmitter is built by Telonics, Inc.

SCOPE

The tagging will involve only gray whales in the vicinity of Point Barrow and, perhaps, Kaktovik because movements of whales in and around the proposed Beaufort Sea Lease Area are of primary interest. Only up to six whales will be tagged initially to determine the suitability of the radio-tag. Bowhead whales will not be tagged because of serious reservations expressed by the North Slope Borough Mayor's office.

A radio-tag was conceptually designed that will be attached to a whale such that less than 3 inches of the tag penetrates the skin and blubber; the remainder of the tag remains on the surface of the whale. The tag will only transmit when the whale is surfaced due to the effects of salt water on radio signals.

Tagging of whales will take place at Barrow and perhaps Kaktovik in summer and fall, 1979, thus increasing the probability of having tagged whales in the Beaufort Sea during the period when these animals potentially utilize the waters in and around the proposed lease area.

RESULTS

Available literature on all aspects of whale tagging and radio-tags used for marine mammals was accumulated. In addition, literature pertinent to whales in the Beaufort Sea and other Alaskan arctic waters was obtained. This information was useful in determining the state-of-the-art of radio-tag technology for use in marine waters and in planning the proposed work in the Beaufort Sea.

Communication was established with Larry Hobbs of the Marine Mammal Tagging Office, Bill Watkins of the Woods Hole Oceanographic Institution, and Jim Johnson of the National Marine Fisheries Service in Seattle. All discussion related to the problems of tagging large cetaceans. Watkins was instrumental in the development of the tag built by OAR that was used on several species of large cetaceans.

Radio-tags and receivers were ordered from Telonics, Inc. This radio is smaller and less powerful than that built by OAR. A meeting was held with Telonics to discuss aspects of the electronics, the machining tolerances of the capsule, transmitting antenna options, and the gun used to project the dart. Also, discussions were held to determine the modifications necessary to allow the transmitter to be received on a OAR Automatic Direction Finder (ADF) which is less sensitive than the Telonics receiver. Telonics could not modify the ADF to increase its sensitivity and increasing the duty cycle of the transmitter would approximately halve its life expectancy. Modification of the ADF by OAR to allow reception of the Telonics tag would require about 25 percent increase in cost of the ADF.

Several meetings were attended with the entire project staff to discuss objectives and means of sharing equipment and logistical support, and to encourage cooperation with other groups also working on or interested in whale research in arctic and subarctic waters.

Meetings were held with the Alaska Eskimo Whaling Commission (AEWC) to discuss the tagging program and to seek advice concerning tagging procedures and attachment devices. Preliminary indications were that the Telonics tag would cause little or no problem to whales due to its small size and external attachment. Use of the larger OAR tag, which penetrates deeply into the blubber, was discouraged by the AEWC representatives.

ABSTRACT

State-of-the-art information regarding tagging of whales was accumulated. A new radio-tag was conceptually designed. Radio-tags and receivers were ordered. Communication with various government and civic groups and with individuals was established.

INVESTIGATOR

Rita A. Homer, Ph.D.

STATEMENT OF TASK

The biomass levels of zooplankton in the Beaufort Sea will be determined, in particular those species that are major food sources for bowhead, gray and Pacific right whales. Also , a bibliography on the biology, especially food habits, of bowhead, gray and Pacific right whales till be prepared.

PURPOSE

It is important to know the numbers, kinds, biomass and distribution of organisms that are available as food for whales. The literature search was necessary to know what information was already available on the feeding behavior of the whales and on the organisms utilized as food.

SCOPE

Research began after the fall 1978 migration was over; therefore, the project was limited to the literature search.

RESULTS

A bibliography on the biology of the bowhead, gray and Pacific right whales was begun, making use of the facilities of the NOAA Environmental Data Services (OASIS - Oceanic and Atmospheric Scientific Information Systems) program on the University of Washington library system. Two hundred and five (205) references have been obtained and sorted into major topics (Table 1) and listed with a brief summary of each paper. This bibliography has been submitted to the Naval Arctic Research Laboratory.

Table 1. Number of References by Major Topic

Topic	Number
Bibliographies	8
General References and Natural History	35
General Distribution	34
Relationship to Sea Ice	3
Populations	16
Food and Feeding	19
Parasites	8
Tagging	11
Sounds, Acoustics	33
Chemistry, Physiology	38

ABSTRACT

A bibliography of 205 references on the biology of the bowhead, gray and Pacific right whales was begun, making use of the NOAA Environmental Data Service OASIS program and the University of Washington library system. These references have been sorted into categories and summarized.

INVESTIGATORS

Thomas F. Albert, V.M.D., Ph.D.

L. Michael Philo, V.M.D.

STATEMENT OF TASK

In endangered whales, determine the basic structure and function of tissues that are likely to be directly or indirectly affected by offshore oil development.

PURPOSE

Central to the understanding of any animal is detailed information concerning the structure and function of its major organ systems. This project addresses the need for assembling and interpreting information concerning critical organ systems that may be affected by offshore oil development. The studies will be primarily structural in nature (gross and microscopic) with function assessed in the light of structural and clinical chemical findings. The major emphasis will be placed upon the tissues which are most likely to evidence adverse effects, either direct or indirect, as a result of oil pollution.

Objectives

1. To obtain basic biological information about individual endangered whales, utilizing animals captured by the Eskimo hunters, as well as stranded whales. Areas of particular interest include the structure of those tissues most likely to be adversely affected, either directly

or indirectly, by offshore oil development. Such tissues include the visual apparatus, digestive tract, reproductive tract, skin and respiratory structures. In line with this, values for the tissue concentrations of toxic substances (e.g. heavy metals), should be determined prior to offshore activity. In addition, a search will be made in all tissues examined for evidence of age-related changes and changes indicating disease.

2. To develop data for comparison with future studies to determine the eff.sets of development within the oil lease area on bowhead and gray whales.
3. To provide direct support by means of specimen collection for Research Unit 678 (Trophies).

Rationale

In order to assess the effects of offshore oil development and oil pollution on marine animals, one must know the basic structure of critical organ systems as well as 'redevelopment levels' of toxic substances in tissues.

Objective 1 responds directly to the work statement in that tissue levels of toxic compounds are to be determined. The actual determination of the levels of toxic compounds in tissues is one thing; however, an interpretation of the effects of such compounds is quite another matter. If an animal is being injured by toxic compounds, evidence is usually evident through microscopic examination of the animal's tissues. In order for one to detect evidence of injury, the normal histological structure of tissues must be known. Objectives

1 and 2 respond indirectly to the work statement by addressing aspects of Section 7 of the Endangered Species Act, in particular, the direct and indirect effects of oil contamination upon an animal. Since it is not possible to directly contaminate a whale with oil, the normal structure of critical tissues must be determined at the outset. As offshore development progresses, an endangered whale may become oil contaminated. If the animal is available for study (stranded or hunter killed) a pathological evaluation of its affected tissues will be made in light of the known normal histological structure of its tissues.

Similarly, it is only through knowledge of the detailed structure of critical tissues that many of the direct and indirect effects of offshore development can be assessed. For example, what till be the effects of development (drill rigs, ship traffic, noise) upon migration routes and reproduction? Vision likely plays a major role as the animal proceeds along the migratory route. Knowledge of eye structure, for comparison with better studied mammals, will allow inferences to be made concerning visual acuity to assess ability to avoid debris, oil rigs and support cables that may occur. Also, knowledge of reproductive tract structure, for comparison with better studied mammals, will allow inferences to be made concerning the whale's basic reproductive behavior and how it is likely to be affected by offshore development.

The following critical organ systems will be studied.

The digestive system (mouth, stomach, liver, pancreas, intestines). The ingestion of spilled oil or oil-contaminated food poses an obvious threat and requires that the normal structure of the digestive tract be determined.

The reproductive system (gonads, penis, uterus, etc.). The long-term, low-level ingestion of oil polluted materials poses an unknown threat to the animal's reproductive process. It is unknown if the effect of increased noise and other disturbances associated with offshore drilling and production (ship and aircraft traffic, drilling structures in migration route, etc.) could interfere with reproductive activity. Our data could contribute important information to future assessment.

Findings from reproductive tract studies will be related to radiographic findings on the state of physical maturity and physical measurements such as body length. Obvious areas of interest will be relationships between body length, state of physical maturity, onset of reproductive capability, reproductive disease, and age related reproductive changes seen in better studied mammals.

Knowing the relative age structure of the population (i.e. physically mature vs. immature) and estimated reproductive capability (i.e. level of reproductive maturity and sustained capability) will help assess the ability of the population to withstand stresses which may be imposed by offshore drilling. Also, the continued study of these areas of interest during the long-term course of drilling operations will help determine whether any detrimental effects to the population have occurred.

Tissues and organs associated with perception of and movement within the aquatic environment (eyes, skin, respiratory structures, bone structure, muscle, flipers, flukes). Spilled oil or discharges from passing ships or drilling platforms could result in injury to the eyes and skin. An understanding of the visual apparatus becomes more important as the endangered whales' path becomes more altered with items such as ships, drilling platforms, underwater support cables and floating and submerged debris. Any significant injury to the skin could be lethal because the skin has both sensory and thermoregulatory functions. Fouling of the blowhole with oil could lead to the inhalation of oil itself or its vapors. Such inhalation could lead to respiratory impairment ranging from reduction of alveolar gaseous exchange to death.

Objective 3 responds directly to the work statement in that this research unit is part of an interdisciplinary study in which cooperation among the research units is emphasized.

SCOPE

This research unit is concerned with endangered whales occurring in the proposed lease area. Examination of individual whales is limited to those which are either hunter killed or stranded. During fall, hunter killed whales are only available in Barrow to the west of the lease area and Kaktovik to the east. It must be noted that although the bowhead whale ranges throughout much of northern Alaskan coastal waters, it can only be sampled in certain geographic locations (whaling villages).

MATERIALS AND METHODS

In order to meet the above objectives the following steps must occur: (1) obtain ready access to captured or stranded whales; (2) carefully collect specimens from predetermined areas; (3) preserve the material; (4) safely transport the specimens to the appropriately equipped laboratory; and (5) have the material examined by qualified personnel.

During the fall whaling season Eskimo hunters regularly capture bowhead whales at Barrow and Kaktovik. Neither of these sites are within the proposed lease area, however they are the only sites at which harvested animals can be examined during the fall. Barrow is to the west of the proposed lease area and Kaktovik is to the east.

Whales that could be reached were examined in as much detail as was practical under the existing environmental conditions. Tissue samples were collected, preserved (10% buffered formalin), and some were forwarded to cooperating scientists for histological examination. It is essential that collected material be examined in as much detail as possible. In order to accomplish this we have enlisted the aid of interested and highly trained personnel whose laboratories possess the needed instrumentation. Listed below are the cooperating scientists who are presently associated with this study and their areas of particular interest.

George Migaki, D.V,M., Chief Pathologist, Registry of Comparative Pathology, Armed Forces Institute of Pathology, Washington, D.C. Areas of interest: histopathology, general histology.

Robert M. Kenney, D.V.M., Ph.D., Chief of the Section of Reproductive Studies, School of Veterinary Medicine, University of Pennsylvania, Philadelphia, Pennsylvania. Areas of interest: reproductive system, lymphatic system.

William Medway, D.V.M., Ph.D., Chief of the Section of Clinical Laboratory Medicine, School of Veterinary Medicine, University of Pennsylvania, Philadelphia, Pennsylvania. Areas of interest: clinical chemistry of blood and urine.

Allen L. Ingling, B.S.E.E. , V.M.D., Department of Veterinary Science, University of Maryland, College Park, Maryland. Areas of interest: heavy metal and pesticide toxicology, baleen hardness.

Gustavo D. Aguirre, V.M.D., Ophthalmologist, School of Veterinary Medicine, University of Pennsylvania, Philadelphia, Pennsylvania. Areas of interest: eye structure and function.

Richard R. Dubielzig, D.V.M., Department of Pathology, School of Veterinary Medicine, University of Pennsylvania, Philadelphia, Pennsylvania. Areas of interest: eye structure and function.

RESULTS

During the fall 1978 whaling season only four whales were available for examination. The findings are described for each of the four whales.

Bowhead Whale - 78KK1. This whale was struck on 15 September 1978, by Herman Aishanna in the waters off Kaktovik, Alaska. The animal was lost due to an approaching storm which forced the hunters to return to shore. With the aid of a local flying service, the hunters located the whale on 21 September, approximately 45 miles to the west of Kaktovik and 6 miles from shore. The animal was then beached in that area. Due to the length of time that the animal had been dead only the skin with some underlying blubber (muktuk) and the baleen, flukes and flippers were harvested. The animal was considered a 'stinker' due to internal decomposition. There were several irregular areas of white skin in the area of black skin. These are apparently scars (Fig. A). One such site was due to a healed penetrating injury. We speculate that this penetrating injury was due to a harpoon or bomb penetration received from

Fig. A. Bowhead whale 78KK1, taken by Herman Aishanna, Kaktovik, Alaska. Muktuk being removed. Note areas of white skin (white arrows) , which are apparently scars. The head, which has been removed, can be seen in the water behind the remainder of the carcass. Baleen (black arrow) can also be seen. One can also note the use of various tools for the removal of the muktuk and that the major portion of the flukes have already been removed.

Fig. B. Small gray whale found stranded approximately 12 miles southwest of Barrow. Ice is being removed from carcass in order to obtain tissue specimens. Right flipper was removed for subsequent radiographic study. Note barnacles (arrows) on skin. The animal was located through aerial survey.

Eskimo hunters during some earlier whaling season. This finding is significant in that it lends support to the feeling that at least some whales survive after having been struck and lost. This site of injury was examined in detail and has been set forth in manuscript form. It has been submitted to the publication Marine Fisheries Review for inclusion in the issue dedicated to the bowhead whale. A copy of the manuscript is in Appendix C. Only one eye was available for examination.

Bowhead Whale - 78KK2. This whale was struck on 26 September 1978, by Nolan Solomon in the waters off Kaktovik, Alaska. It was beached the next day. It was a male, 43 feet, 9 inches in length. Due to attendance at a PROJECT WHALES meeting in Anchorage, word of the animal's capture was delayed in reaching us. Samples were collected on 28 September from what remained on the beach at Kaktovik after the butchering. Only a few samples could be taken from what remained on the beach. One eye was collected.

Gray Whale #1. This whale was found dead along the beach, approximately 12 miles southwest of Barrow, Alaska. It was a female, 25 feet, 6 inches in length. The animal was examined on 6 October 1978. Since the animal was partly in the surf, we were not able to examine it thoroughly (Fig. B). The cause of death was not determined, however we suspect that it may have been the animal that hunters were firing at with rifles a few weeks earlier near Barrow. A louse was found among the baleen and it was forwarded to Dr. A. Grundmann, University of Utah for identification. The skin of the right side, which was in view, evidenced at least 100 barnacles, each 1 to 1-1/2 inches in diameter. Samples were collected, preserved in 10% buffered formalin and are being examined by a cooperating scientist (Dr. Migaki). The barnacles apparently caused very little skin damage and the histopathological findings are included in a manuscript which is in preparation. The right flipper was removed and transported to the Naval Arctic Research Laboratory, Animal Research Facility for radiographic study. The flipper was radiographed ("X-rayed") in detail. Examination of the radiographs shows that the bones of the flipper include the humerus, radius, ulna, five carpal bones, four metacarpal bones, three phalanges in the second digit, five phalanges in the third digit, four phalanges in the fourth digit and apparently three phalanges in the fifth digit. The major item of interest was the distal epiphyseal plate ("growth plate") in the humerus which is clearly visible (Fig. C). Since this plate is still present the humerus is still growing and the animal has not reached physical maturity. When an animal reaches physical maturity (maximum growth) the epiphyseal cartilages are replaced by bone. We feel that the radiographic examination of bowhead whale flippers will allow for the determination of state of physical maturity based upon the presence or absence of the distal epiphysis of the humerus.

Gray Whale #2. This whale was seen dead in the water near shore approximately 5 miles to the east of Point Barrow. It was a male, approximately 35 feet in length (Fig. D). Before any attempt could be made to examine this animal it was washed away in a storm and not seen again.

Fig. C. Radiograph of portion of gray whale flipper. Three bones are visible: the humerus above; the radius at the lower left; and the ulna at the lower right. These three bones form the elbow joint. The distal epiphysis ("growth plate") of the humerus and the proximal epiphysis of the radius and of the ulna are all visible as black lines and are indicated by black arrows. The presence of these epiphyseal plates indicates that the bones are still growing and therefore, the animal is physically immature. Such epiphyseal plates would not be present in bones of a physically mature animal. The elbow joint is indicated by white arrows. Note the several barnacles visible on the skin overlying the ulna.

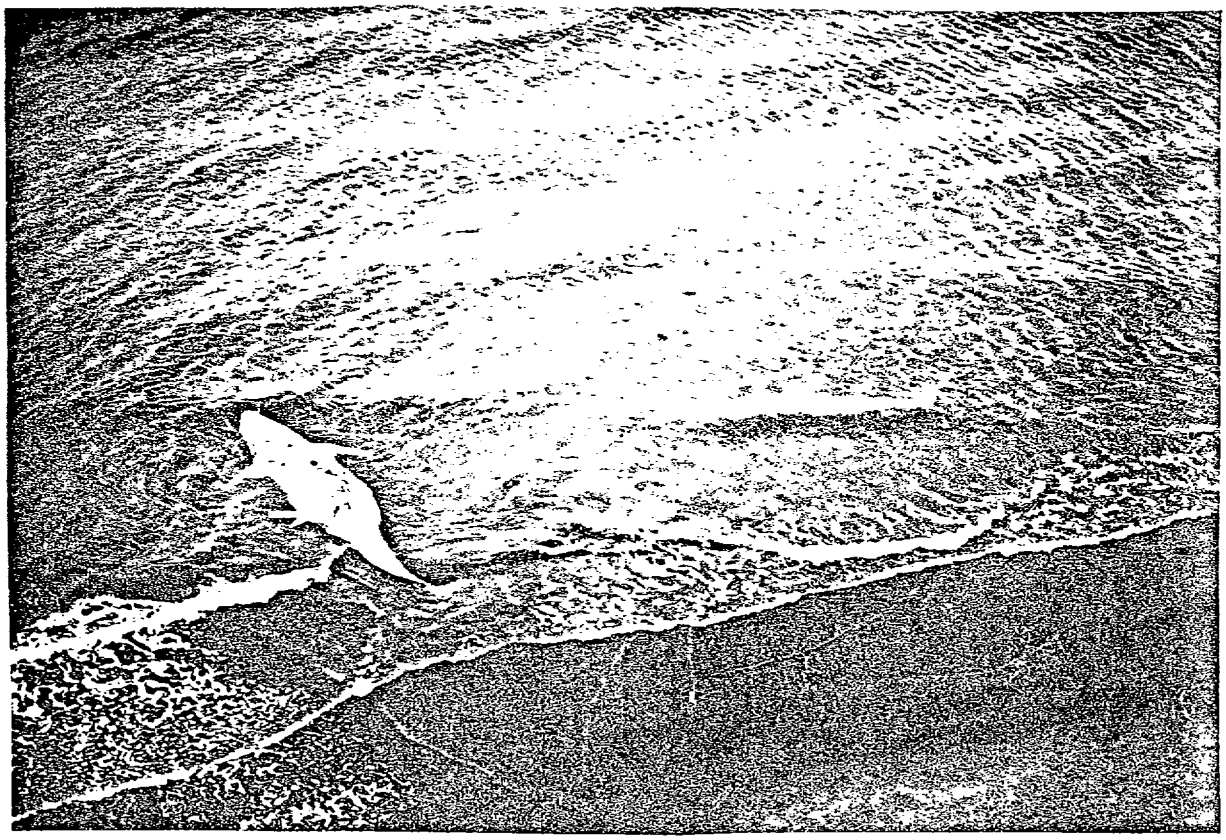


Fig. D. Gray whale, approximately 35 feet in length, found stranded approximately 5 miles east of Point Barrow. The whale is floating with the ventral aspect up, note penis (arrow) . The animal was located through aerial survey.

Examination of Bowhead Whale Eyes

The examination of the eyes was performed by Dr. Gustavo Aguirre and Dr. Richard Dubielzig. Three eyes were examined; one from whale 78KK1, one from whale 78KK2 and one eye from a whale taken at Barrow 2 or 3 years earlier. The gross physical measurements are presented in Table 2.

Table 2. Physical Measurements (mm) of Three Bowhead Whale Eyes

Measurement	Barrow Whale	Whale 78KK1	Whale 78KK2
anterior-posterior	50	48	53
medial-lateral	72	70	77
dorsal-ventral	73	72	76
optic nerve diameter	5	4	5
lens axial	10	11	11
lens equatorial	13	14	13

These measurements are roughly equal to those recorded for other similar sized whales (Yablokov *et al.*, 1972). On sectioning the globe several of the gross characteristics were similar to those of other cetaceans (Yablokov *et al.*, 1972), These include a nearly round lens, a thick fibrous sclera, a vascular plexus surrounding the optic nerve and an oval horizontally flattened pupil. Only the eye from the 78KK2 whale was preserved well enough to allow adequate histological examination. Sections from the eye showed a muscular iris with a well formed constrictor muscle, a cornea which thins centrally and thickens peripherally, a lack of well formed ciliary muscle, sensory corpuscles in the ciliary body, a neurovascular plexus surrounding the optic nerve and continuous with the choroid. The retina was poorly fixed but sections from peripheral retina were adequate to show that the standard 10 layers *were* present. Giant ganglion cells similar to those seen in other cetacean eyes were found. All of these findings have been previously described in cetacean eyes (Dawson *et al.*, 1972; Dawson and Perez, 1973; Dral, 1977; Perez *et al.*, 1972; Vrabec, 1972; Yablokov *et al.*, 1972).

From this very limited structural study of the bowhead whale eye it would seem that the bowhead is capable of vision but the degree of acuity could not be determined from this material due to poor fixation of the retina.

Coordination of Efforts with Eskimo Hunters

Adequate examination of killed bowhead whales is not possible without the full cooperation of Eskimo hunters. Such cooperation comes only through the establishment of a personal rapport with individual whaling captains, members of the Alaska Eskimo Whaling Commission and officers of the Barrow Whaling Captains Association. Every effort is made to keep the successful whaling captains and the two organizations mentioned above, informed as to the objectives achieved and results obtained by this research unit.

ABSTRACT

Detailed tissue structure studies are underway involving hunter killed and stranded endangered whales. Two hunter killed bowhead whales and two stranded gray whales were seen during the fall 1978 whaling season. A very significant finding was the healed penetrating injury noted in one bowhead. This strongly supports the feeling that some whales survive after having been struck and lost. A gray whale flipper was examined radiographically. The detection of the distal epiphysis (“growth plate”) in the humerus indicates

that a similar study of bowhead flippers should be practical. Such a radiographic study should allow for the separation of captured whales into physically immature and physically mature groupings. Both of the gray whales seen were located through limited aerial survey, pointing out the need for such aerial searches, particularly between Barrow and Kaktovik. Much effort has been expended in meeting with individual hunters and with Alaska Eskimo Whaling Commission members. Since the success of this research unit depends upon obtaining tissue samples from whales being butchered by hunters, it is essential that a personal working relationship with the hunters be formed. In order to maximize the study of collected tissues, the aid of interested and highly competent cooperating scientists has been enlisted.

PUBLICATIONS AND REPORTS

The following manuscripts were completed or in preparation during fall 1978, for Research Unit 578.

Albert, T. F., G. Migaki, H. W. Casey and L. M. Philo. Healed Penetrating Injury of the Bowhead Whale, *Baleana mysticetus*. Submitted to: Marine Fisheries Review (special bowhead whale issue).

Migaki, G., T. F. Albert and L. M. Philo. Skin Lesions Caused by Barnacles in a Gray Whale, *Eschrichtius robustus*. In preparation; to be submitted to the Journal of the American Veterinary Medical Association.

REFERENCES

Dawson, W. W., L. A. Birndorf and J. M. Perez. 1972. Gross anatomy and optics of the dolphin eye. *Cetology* 10:1-12.

Dawson, W. W. and J. M. Perez. 1973. Unusual retinal cells in the dolphin eye. *Science* 181:747-749.

Dral, A. D. 1977. The retinal anatomy of cetacea. *In: Functional Anatomy of Marine* Mammals, Vol. 3, R. J. Harrison, editor. pp. 81-133.

Perez, J. M., W. W. Dawson and D. Landau. 1972. Retinal anatomy of the bottle nosed dolphin. *Cetology* 11:1-11.

Vrabec, F. 1972. Encapsulated sensory corpuscles in the sclerocorneal boundry tissues of the killer whale, *Orcinus orca*. *Acta Anatomica* 81:23-29.

Yablokov, A. V., V. M. Blekovich and V. I. Borisov. 1972. Whales and Dolphins, Part I, Nauka, Moscow, 472. (National Technical Information Service translation) .

INVESTIGATORS

John J. Burns, M.S.

Lloyd F. Lowry, M.S.

This project was funded after the fall 1978 whale migration period. The Principal Investigators submitted a letter of withdrawal from the program. Activity on this research unit is scheduled for the spring migration period and will be conducted by Drs. Lee Braithwaite and Ferron Andersen of Brigham Young University.

STATEMENT OF TASK

To study the food habits of endangered bowhead and gray whales in the Beaufort Sea with special emphasis on the proposed Federal/State Beaufort Sea Lease Area.

PURPOSE

1. To determine the food of bowhead and gray whales from collections made by Research Unit 579.
2. To identify pelagic prey species found in the alimentary canal of these whales.
3. To determine the relative abundance of potential benthic prey organisms in the open-water lead areas of the ice.

SCOPE

This program will begin in Spring 1979.

INVESTIGATORS

Charles D. Evans, M.S.

Larry S. Underwood, Ph.D.

STATEMENT OF TASK

A report describing background information on endangered whales in the waters in and around the proposed Federal/State Beaufort *Sea* Lease Area will be completed as well as production of PROJECT WHALES' reports.

PURPOSE

1. Prepare background description of the study area during the fall/ spring migration period of endangered whales.
2. Synthesize into final form researchers' reports on the fall 1978, whale migration and habitat conditions.

RESULTS

The references that follow were accumulated and reviewed.

REFERENCES

Alaska Geographic. 1978. Alaska whales and whaling. Alaska Northwest Publishing Co., Alaska Geographic Society, Vol. 5., No. 4. 144 pp.

Reviews ancient and current practices of whaling by both Native and non-Native cultures. Generalized distribution maps are presented for ten species, along with two maps depicting worldwide kill by the month for black-right, bowhead, and humpback whales.

Allen, A. J. 1978. A whaler and trader in the Arctic, 1895 to 1944: My life with the bowhead. Alaska Northwest Publishing Co., Anchorage. 213 pp.

Recounts the life of a non-Native whaler who lived out his adult life in the Arctic. Author reports that commercial whaling began each year

by the end of April along leading edge of the ice pack in the Bering Sea along the Siberian shore. At this season bowheads were found up to East Cape, USSR; later in the year whalers followed the bowhead easterly to Point Hope, then to Barrow. Bowheads characteristically would submerge for twenty minutes at a time when pursued. Running of ship's motors always frightened bowheads, making capture impossible. Author killed the "whistling whale", a bowhead hunted for many years which produced a loud whistle with every blow. Bowheads staged occasional deliberate attacks on approaching whale boats. Observations on life in the Arctic, e.g. Native customs, traditions, etc., comprise the bulk of the narrative.

Andersen, H. T. (cd.). 1969. The biology of marine mammals. Academic Press, New York, New York. 511 pp.

Summarizes the general biology of marine mammals. Chapters are devoted to age determination, hydrodynamics of swimming, deep diving, physiological properties of blood, cardiovascular adjustments to diving, temperature regulation, nervous system, reproduction and reproductive organs, endocrine systemology and echolocation.

Banfield, A. W. F. 1974. The mammals of Canada. University of Toronto Press, Toronto. 438 pp.

Maps depicting distribution and 'keys to North American genera of cetaceans are presented.

Bockstoce, J. R. 1977. Steam whaling in the western Arctic. Old Dartmouth Historical Society, New Bedford, Massachusetts. 127 pp.

Traces the history of American steam whaling vessels from 1879 onward, as employed in the capture of the bowhead. Whale ships staged at Dutch Harbor in April and began hunting along the retreating edge of the ice pack. By late June the steamers could force their way into the Arctic Ocean, retreating in late September or early October.

_____. 1978. A preliminary estimate of the reduction of the western Arctic bowhead whale (*Balaena mysticetus*) population by the pelagic whaling industry: 1848-1915. New Bedford Whaling Museum. New Bedford, Maine. Report for U.S. Marine Mammal Commission. Available from: National Technical Information Service, Springfield, Virginia. PB-286-747. 32 pp.

This report estimates the total kill of bowhead whales by commercial interests between the years 1848 to 1915. Data were gathered from logbooks and maritime newsletters. Author estimates that between nineteen thousand one hundred forth-two and twenty-one thousand four hundred forty-eight bowheads were taken during those years. Whaling commenced in earnest at latitude 57° to 58°N in spring, progressing north and east as the ice retreated.

Bowen, S. L, 1974. Probable extinction of the Korean stock of the gray whale (*Eschrichtius robustus*). Journal of Mammalogy. 55(1):208-209.

No gray whales were sighted by the author in Korean waters during the years 1970-71 and 1971-72. In 1970, seven hundred forty whales were captured by Korean whalers who were unfamiliar with the gray; fishermen and ship captains reported never seeing a whale resembling a gray, and no one could recall seeing or hearing of a whale habitually found in nearshore waters. The author concludes that the Korean stock of gray whale is extinct.

Braham, H. W. and B. D. Krogman. 1977. Population biology of the bowhead (*Balaena mysticetus*) and beluga (*Delphinapterus leucas*) whale in the Bering, Chukchi and Beaufort Seas. U.S. National Marine Fisheries Service, Seattle, Washington. Northwest and Alaska Fisheries Center. Processed Report. 29 pp.

Distribution and abundance of bowhead and beluga whales are described from data collected in 1976 and extant information. Authors propose that during spring migration an unknown segment of the bowhead population transits offshore leads north, past Point Barrow, Alaska to Banks Island, Canada. Fall concentrations of bowhead are reported between Point Barrow and Smith Bay.

Camerino, V. 1977. Case of the bowhead whale. American Indian Journal. (Dee.):23-25.

Presents in a popular style, the opposing views of Eskimo whale hunters and the International Whaling Commission.

Carrel, G. M. 1976. Utilization of the bowhead whale. Marine Fisheries Review. 38(3):18-21.

Provides an overview of Native utilization of the bowhead whale as food, material for tools and cultural importance.

Chapman, D. G., L. L. Eberhardt and J. R. Gilbert. 1977. A review of marine mammal census techniques. University of Washington, Seattle. Report for U.S. Marine Mammal Commission. Available from: National Technical Information Service, Springfield, Virginia. PB-265 547. 55 pp.

Mark-recapture, catch per effort, visual counting techniques and equations for estimating abundance and variance are reported. A discussion of difficulties in utilizing these techniques is given. Areas in need of further research are discussed.

Davidson, A. No date. Eskimo hunting of bowhead whales. Rural Alaska Community Action Program, Anchorage. 37 pp.

Reviews the regulatory status of bowhead whales, Native utilization and dependence on the whale, impact of Native whaling on the stock, and options for preserving the stock and aboriginal life-styles.

Durham, F. E. 1972. History of bowhead whaling and Greenland or bowhead whale. Pages 5-14 in A. Seed, comp. Baleen whales in eastern north Pacific and Arctic waters. Pacific Search, Seattle, Washington.

This report briefly reviews techniques of catch and utilization of the bowhead whale by man. A brief overview of their biology and distribution is included.

______. 1973. Eskimo fact and fiction about the bowhead whale. Pacific Search. 7(4):8-10.

Briefly recounts some Eskimo beliefs about the bowhead whale.

Eberhardt, R. L. and K. S. Norris. 1964. Observations of newborn Pacific gray whales on Mexican calving grounds. Journal of Mammalogy. 45(1): 88-95.

Describes neonate characteristics, parasites, effect of predation, and allometric growth among newborn gray whales.

Evans, C. D. and L. S. Underwood. 1978. How many bowheads? Oceanus. 21(3):17-33.

The International Whaling Commission rationale for limiting the take of bowhead whales by aboriginal, public reaction to that ruling, and official United *States* position are summarized. A review of the data used by the IWC in reaching their decision concludes that too little is known of the bowhead population biology to reach any judgment concerning overall population numbers.

Fiscus, C. H. 1974. Bowhead whale research at NWFC. Northwest Fisheries Center Monthly Report. August. 6 pp.

Distribution, general biology and status of the bowhead whale are reviewed.

Fraker, M. A., D. E. Sergeant and W. Hock. 1978. Bowhead and white whales in the southern Beaufort Sea. Canadian Department of Fisheries and the Environment, Victoria, B.C. Beaufort Sea Project. Technical Report No. 4. 114 pp.

Seasonal concentrations of beluga at the mouth of Mackenzie River in late June are correlated with onset of calving. All sex and age classes are present. Authors speculate that belugas seek out warmer river water for calving (up to 18°C). Basic population biology of the beluga and Native patterns of utilization are reviewed. Authors report beluga migration route along leading edge of sea ice from Bering Sea to Banks Island in spring, and the reverse in fall. The authors feel bowhead whales follow same pattern, noting observations of the two swimming together. General review of bowhead food, habits, reproductive biology and timing of migrations are presented. A section on possible effects of current oil and gas exploration is included.

Foote, D. C. *1974.* Observations of the bowhead whale at Point Hope, Alaska. McGill University, Montreal. Report for U.S. Atomic Energy Commission. 76 pp.

Observations gathered during three field seasons by only non-Native member of Eskimo whaling crew are presented. A review of bowhead migration routes and their relation to sea ice conditions is given. The first bowheads seen in spring arrive in company with, or shortly after, the first beluga. Eskimos firmly believe the spring migration is divided into three distinct groups which pass in early April, late April and mid-May. Historic records supplied by the author and field observations confirm this. Copulating animals were observed at close range (6 feet) and one was heard to vocalize ". . . as if a bull had roared inside a great closed chamber". The author reviews the arguments that two similar species of baleen whale exist in the area.

Gard, R. 1978. Aerial census, behavior and population dynamics study of gray whales in Mexico during the 1974-75 calving and mating season. University of Alaska, Juneau. Prepared for U.S. Marine Mammal Commission. Available from National Technical Information Service, Springfield, Virginia. PB-275 295. 18 pp.

Gray whales were observed along the Baja California and western Mexican coast, No repetitive daily activity patterns in Scammon's Lagoon were noted. Total whales counted on wintering ground in 1974 and 1975 were much higher than previously recorded; author attributes this to improved census techniques.

______. *1978.* Aerial census and a population dynamics study of gray whales in Baja California during the 1976 calving and mating season. University of Alaska, Juneau. Prepared for the U.S. Marine Mammal Commission. Available from: National Technical Information Service, Springfield, Virginia PB-275 297. 20 pp.

Author reports gray whales spend about thirty percent of their time at the surface and he uses this figure with the aerial count data to estimate total population.

Gilmore, R. M. No date. The gray whale. Oceans Mag. 1(1):9-20.

Reviews the biology, distribution, migration routes, breeding grounds, and historic commerical whaling for gray whales. Newborn calves measure twelve to seventeen feet, weigh one- to three-thousand pounds, sexual maturity occurs between four and five years of age, adults may exceed fifty feet in length, and individuals may live fifty years or more.

_____. 1961. Whales without flukes or flippers. Journal of Mammalogy. 42(3):419-420.

'The author briefly describes reported and personal observations of whales which were missing appendages. A gray whale was observed that had *lost* both flukes. This animal swam on its side ". . . taking advantage of the lateral flattening of the tail . . . The Eskimos in the old days hamstrung the bowheads, *Balaena mysticetus*, that they captured".

Green, K. A. 1969. Review and analysis of the Fishery Conservation and Management Act and regional fishery management plans with respect to the conservation of marine mammals and their habitats. Draft final report for the Marine Mammal Commission. 67 pp. + Appendices.

Biological characterizations for various ocean areas (e.g. Bering Sea-Aleutian Islands) are presented. Present fisheries management schemata and their relationship to marine mammals are examined. This issue has taken on added significance with the passage of the Fishery Conservation and Management Act which extended U.S. fisheries and marine mammal jurisdiction seaward 200 miles.

Grigg, R. W. and T. Dana. 1969. Accidental encounter with a whale. Journal of Mammalogy. 50(4):818-819.

While diving about one-half mile off LaJolla, California to photograph sea fans, the authors were approached by a gray whale. The whale deliberately altered course to view the divers and slowly circled them. On one close approach, one of the divers touched the whale. The startled animal rolled about 30 degrees and accelerated, striking the diver with its tail. Uninjured, but dazed, the diver survived. The authors considered the incident accidental, not deliberate.

Hall, E. R. and K. R. Kelson. 1959. The mammals of North America. The Ronald Press Co., New York, New York. 1083 pp.

The authors present a concise key to North American cetaceans and general notes on distribution.

Hatler, D. F. and J. D. Karling. 1974. Recent observations of the gray whale, *Eschrichtius robustus*, in British Columbia. Canadian Field Naturalist. 88(4):449-460.

Author reports that spring migration peaks in early April. Observations are reported which confirm nearshore migration of this whale in Canadian waters.

Hershkovitz, P. 1966. Catalog of living whales. Smithsonian Institution, Washington, D.C. Bulletin 246. 259 pp.

Reviews the general taxonomy of cetacea. General notes on distribution are also provided.

Kristof, E. 1973. The last U.S. whale hunters. National Geographic. 143(3):346-353.

The author recounts in popular style, the Eskimo method of hunting bowhead whales.

Lowry, L. F., K. J. Frost and J. J. Bums. 1978. Food of ringed seals and bowhead whales near Point Barrow, Alaska. Canadian Field-Naturalist 92(1):67-70.

Stomach contents of 16 ringed seals (*Phoca hispida*) and two bowhead whales (*Balaena mysticetus*) taken in the vicinity of Point Barrow are reported. Entire contents of the seal stomachs were utilized, while only small subsamples of the contents of the whales' stomachs were examined. Over three-quarters of the combined total volume of the seal stomach contents was euphausiids (*Thysanoessa inermis* and *T. raschii*) . Gammarid amphipods (*Anonyx nugax, Gammaracanthus loricatus, Acanthostepheia behringiensis, Gammarus zaddachi,* and *Atylus*) were also present but comprised only 4.6 percent of the combined total volume. Hyperiid amphipods (*Parathemisto libellula* and P. *abyssorum*), found only in association with euphausiids accounted for 0.3 percent of the combined total volume of seal stomachs. Isopods (*Saduria entomon*) were found in only two stomachs, one of which contained 200 ml of them. Shrimp (*Sclercrangon boreas, Libbeus polaris* and *Pandalus* spp.) , mysids (*Mysis litoralis, Neomysis rayii*), squid (*unidentified*) and fish were also taken by seals. Otoliths of 30 polar cod (*Boreogadus saida*), two capelin (*Mallotus villosus*), and one saffron cod (*Eleginus gracilis*) were identified. Small subsamples of bowhead whale stomachs (17.5 ml and 33.0 ml.) from two specimens reveal that they had been feeding on euphausiids (*Thysanoessa raschii*), gammarid amphipods (*Gammarus zaddachi, Acanthostepheia behringiensis, Monoculoides zernovi,* and *Rozinante fragilis*), and a hyperiid amphipod (*Parathemisto libellula*). Euphausiids comprised 90.3 percent of the total combined volume, gammarid amphipods 6.9 percent and the hyperiid amphipod 2.7 percent.

Maher, W. J. and N. J. Wilimovsky. 1963. Annual catch of bowhead whales by Eskimos at Point Barrow, Alaska, 1928-1960. Journal of Mammalogy. 44(1):16-20.

An average of 5.8 bowhead whales were taken each year between 1928 and 1960 by Eskimos at Point Barrow for a total of 191 animals;

seventy-two of them in mid-May. None were killed in seven of the years, and ten or more were taken in seven other years. From 1953 to 1960, forty-seven of the 50 whales captured were taken in only three of the years. Eighty-eight percent of the catch was less than forty feet in length and presumably subadult; the largest measured sixty-one feet. A newborn calf was reportedly taken. A g-ray whale was killed by Wainright whalers in 1954, and it is believed that another was taken in 1951.

Marquette, W. M. 1976. Bowhead whale field studies in Alaska, 1975. Marine Fisheries Review. 38(8):9-17.

Author reports results of 1975 field studies and provides a brief summary of Native whaling techniques, whale migration, whaling effort and Native use of other vertebrates. During 1975, fifteen bowheads were caught, two killed but lost, and twenty-six others struck but lost. Tables report belugas taken and sighted at Point Hope and biological features of bowheads taken in the spring of 1975.

______. 1976. National Marine Fisheries Service studies relating to the bowhead whale harvest in Alaska, 1975. U.S. National Marine Fisheries Service, Seattle, Washington. Northwest Fisheries Center. Processed Report: 31 pp.

Describes current whaling practices and number of whales sighted, killed and recovered, and struck and lost at both Point Hope and Point Barrow, during the 1974-75 whaling season. A review of traditional use of the whale is provided describing its importance as food for man and dogs, heat and light, implement manufacture, traps, walking sticks and toys.

McVay, S. 1973. Stalking the Arctic whale. American Scientist. 61 (Jan-Feb):24-37.

Personal observations from 1971 field work are given along with a review of literature. The bowhead is reported in early literature (1889) to produce an audible sound ". . . something like the hoo-00-00 of the hoot owl . . ." Bowhead spring migration proceeds to the north and east near shorefast ice in three runs from mid-April through June. Recent Eskimo kills of bowhead measuring 67 and 68 feet long are reported along with W. Scoresby's note (1820) that he had not encountered one greater than 58 feet in length. An "albino" bowhead is reported to have been sighted by Natives.

Miller, G. S., Jr. and R. Kellogg. 1955. List of North American recent mammals. Smithsonian Institution, Washington, D.C. 954 pp.

Describes morphological characters and general distribution of all North American cetacea.

Morejohn, G. C. 1968. A killer whale-gray whale encounter. Journal of Mammalogy. 49(2):327-328.

Two killer whales of a pod of seven were observed attacking one member of a pod of three gray whales on 2 May 1967 near Monterey, California. One killer whale was seen to bite the underside of the gray as it rolled sideways. One of the gray whales, accompanied by a calf, escaped by swimming into the breaker line (water depth 2-3m). The killer whales broke off the chase of those two ". . . some 275 m from shore . . ." The ultimate fate of the lone gray whale was not determinable, but a single whale was seen to surface and blow in the area of the attack moments after the incident.

Munger, J. F. 1852 (Reprinted 1967). Two years in the Pacific and Arctic Oceans and China; being a journal of everyday life on board ship, interesting information in regard to the inhabitants of different countries, and the exciting events peculiar to a whaling voyage. Ye Galleon Press, Fairfield, Washington. 80 pp.

This diary of a young seaman describes his life aboard a whaling vessel. The author was a capable observer, and his comments are of general interest.

Nemato, T. 1964. School of baleen whales in the feeding areas, Scientific Reports of the Whales Research Institute, Tokyo, Japan. 18:89-110.

Observations on schools (pods) of baleen whales are reviewed. The author describes sex ratios, total numbers per pod, and sexual maturity as inferred from catch data. Fin whale pods normally number four or fewer on feeding grounds; single animals are sexually mature and may be of either sex; 61 percent of all pairs observed were composed of one male and one female; and males dominate the catch even though females are generally larger.

Norris, K. S. and J. H. Prescott. 1961. Observations on Pacific cetaceans of Californian and Mexican waters. Berkeley University of California Publications in Zoology. 63(4):291-407.

Reports observations made of Cuviers beaked whale, Gray's long-snouted porpoise, Pacific common dolphin, Atlantic bottlenose porpoise, Pacific bottlenose porpoise, northern right whale porpoise, Pacific stripped porpoise, killer whale, fake killer whale, Pacific pilot whale, harbor porpoise, Gulf of California harbor porpoise, Dan porpoise, California gray whale and little piked whale. Distribution, behavior, morphology and techniques of capture are reviewed for respective species. Migrating gray whales are reported to have damaged fishing gear (nets) set in water less than fourteen fathoms deep. "Nets set in 14 fathoms and deeper were seldom molested". Spy hopping or breaching was observed most frequently in areas of deep water, such as undersea canyons,

North Slope Borough, Arctic Slope Regional Corporation and Barrow Whalers Association. 1977. Proposed scope of work for an ocean information system to identify and keep track of the bowhead whale to permit species management, Anchorage. 1 vol.

Proposes an information gathering schemata designed to enumerate bowhead whale numbers. The authors envision the use of electronic sensing devices and collecting information from ships of opportunity, shore observers, aerial photography and surveys, and LANDSAT imagery to locate leads and existing data in literature.

Omura, H. 1974. Possible migration route of the gray whale on the coast of Japan. Scientific Reports of the Whales Research Institute, Tokyo, Japan. 26:1-14.

Prior to the turn of the century, gray whales migrated along the east coast of Japan between feeding grounds in the Sea of Okhotsk and the Seto Inland Sea. The author feels increasing industrial activity and boat traffic displaced the whales from the inland sea and remnants of the population joined the Korean stock.

Omura, H., M. Nishiwaki and T. Kasuya. 1971. Further studies on two skeletons of the black right whale in the North Pacific. Scientific Reports of the Whales Research Institute, Tokyo, Japan. 23:71-81.

Observations on two skeletons are compared with earlier studies on four other specimens, showing that in the skull "the proportional length of the rostrum increases and the rostrum becomes more curved downwards with age, whereas the skull breadth decreases its proportion slightly". Male and female pelvic girdles appear to differ significantly in "form and size". Appended to the report are tables indicating skull and vertebrae measurements.

Orr, R. T. 1969. The gray whale "crisis" of 1969. Pacific Discovery 22(6):1-7.

Observations of the effect of an oil spill at Santa Barbara, California on migrating gray whales are reported. Three gray whales, one sperm whale, and one pilot whale were found dead on the beaches of central and southern California in February and March 1969, subsequent to the oil spill. Necropsy proved inconclusive. A review of the literature showed the degree of mortality recorded was not unusually high, and it was felt that oil contamination was probably not a contributing factor.

Payne, R. and D. Webb. 1971. Orientation by means of long-range acoustic signaling in baleen whales. Annals of the New York Academy of Sciences. 188:110-141.

The potential use of 20 Hz sounds by fin whales as a communicative tool is explored. The authors observe fin whales regularly generate sounds in this range; that these sounds are remarkably strong and capable of being heard long distances (under some conditions across thousands of miles of ocean); and that these sounds are just below storm-generated noise. They postulate that fin whales can communicate (broadcast) their location to all whales in their respective ocean basins, and, therefore, the concept of a herd of whales must be expanded accordingly.

Ray, G. C. and W. E. Schevill. 1974. Feeding of a captive gray whale, *Eschrichtius robustus*. Marine Fisheries Review. 36(4):31-38.

Observations by divers reveal the subject "sucked" food off the bottom while swimming on her side at an approximate 120° angle. Subjects "cheek" was nearly parallel to the bottom during this maneuver. This observation corroborates published accounts predicting this behavior based on assymetrical length of baleen, assymetrical external skin markings (barnacles), and stomach analysis.

Reeves, R. R. 1977. The problem of gray whale (*Eschrichtius robustus*) harassment: at the breeding lagoons and during migration. Smithsonian Institution, Washington, D.C. Report for U.S. Marine Mammal Commission. Available from: National Technical Information Service, Springfield, Virginia PB-272 506. 60 pp.

Basic gray whale biology and behavior are reviewed. Present population estimated at 11,000 and appears to be stabilized. Migration routes are reported. Effects of disturbance from "tourists," scientists, fisherman, salt recovery operators, and oil exploratory activities are discussed. Calves are more susceptible to stranding when disturbed than adults. Gray whales appear to be migrating further offshore because of harassment.

Rice, D. W. 1965. Offshore southward migration of gray whales off southern California. Journal of Mammalogy. 46(3):504-505.

While engaged in tagging fin and sperm whales in southern California waters, the author observed large numbers of gray whales offshore in relatively deep water (1,800 m). He theorizes that an unknown, but significant portion of the population may migrate offshore.

Samaras, W. F. 1974. Reproductive behavior of the gray whale, *Eschrichtius robustus*, in Baja, California. Bulletin of the Southern California Academy of Science. 73(2):57-64.

Precopulative "ritual" is described. Individuals move into specific areas of lagoons in early morning and engage in spyhopping. Late afternoon and early evening are characterized as an intensive period of pairing and copulation.

Scheffer, V. B. and J. W. Slipp. 1948. The whales and dolphins of Washington State with a key to the cetaceans of the west coast of North America. The American Midland Naturalist. 39(2):257-337.

Abbreviated review of the cetaceans of Washington State. Includes a description of the "Kodiak grounds" which extend from Vancouver island northwestward to the Aleutian Chain.

Schevill, W. E. *1952. On* the nomenclature of the Pacific gray whale. Breviora, Cambridge Museum of Comparative Zoology. No. 7. 3 pp.

Dated review of the nomenclature of the Pacific gray whale.

_____. *1974.* The whale problem, a status report. Proceedings of the International Conference on the Biology of Whales, Shenandoah National Park, Virginia, 1971. Harvard University Press, Cambridge, MA. 419 pp.

This report reviews the International Conference on the Biology of Whales held in June 1971. The current status of populations, on-going research, general biology, and management and conservation of various species are discussed. An account of new tagging and tracking methods is included.

Schevill, W. E., W. A. Watkins and R. H. Backus. 1964. The 20-cycle signals and *Balaenoptera* (Fin whales) . Pages *147-152* in Proceedings of the Symposium Marine Bio-Acoustics. Pergamon Press, New York.

Authors argue that the 20 cycles per second pulses recorded worldwide since 1951 are generated by *Balaenoptera physalus*. Repeated observations of fin whales are reported in the area of sound generation.

Scoresby, W. 1820. An account of the Arctic regions with a history and description of the northern whale-fishery. David and Charles Reprints, Redwood Press Limited. Trowbridge Wiltshire, London. 2:574.

This is a comprehensive review of whaling in the early 1800's. At that time Atlantic stocks of bowhead whales supported the fishery. The author observed that larger whales were found farther north. ". . . near the impervious body of ice . . ." in June and that "the smaller animals of this species are . . . found farther to the south . . . most plentifully about fields or floes . . ."

Taber, A. B. 1977. The spring, 1977, gray whale migration through Unimak Pass. U.S. Fish and Wildlife Service and University of California, Santa Cruz, Santa Cruz, California. 17 pp.

Observations of gray whales passing through Unimak Pass during seasonal migration are presented. The author reports that 2,190 whales were observed in 280 hours of observation from shore. Observations began on 7 April and continued for fifty days. Eighty-three calves were recorded. A slight diurnal fluctuation is reported, indicating gray whales may migrate steadily through the night.

Tsuyuki, H. and S. Itoh. 1970. Fatty acid components of black right whale oil by gas chromatography. Scientific Reports of the Whales Research Institute, Tokyo, Japan. 22:165-170.

Authors report the fatty acid components of black right whale oil from one specimen taken south of Kodiak Island in 1962. These components of nine types of blubber and three organs were not found to significantly differ.

U.S. National Marine Fisheries Service. 1977. Final environmental impact statement: International Whaling Commission's deletion of native exemption for the subsistence harvest of bowhead whales. n/p. 2 vols.

Bowhead distribution, inferred migration routes, basic biology, population status, historic harvest, hunting techniques and traditional use by Natives and relation to village economy are discussed. Considers the impact on whale stock and the Eskimo if the United States does or does not object to the IWC recommendation of June 1977 for the Native take of whales to cease.

U.S. National Oceanic and Atmospheric Administration. 1978. Bowhead whales; A special report to the International Whaling Commission (IWC). 63 pp. + Appendices.

In *1977* Eskimos lost 75 percent of the whales struck; this was reduced to 37 percent in 1978. Based on data available as of 30 May 1978, the stock of bowheads available to coastal villages is estimated to be 2,264. The majority of whales in spring migration appear to pass *west* of Big Diomede Island, USSR as they migrate up Bering Strait. From Point Lay north, bowheads were strictly associated with the ice edge. Few were observed in open waters of the leads and none outside of the nearshore lead system. A paired t-test indicated no significant difference between aerial and ice-camp counts. A review of subsistence dependence on this whale is also included.

Walker, E. P. *et al.* 1975. Mammals of the world. The John Hopkins University Press, Baltimore, Maryland. Vol. 2.

Volume two of this standard reference work includes descriptions of species languages and keys to North American cetacea.

Watkins, W. A. and W. E. Schevill. 1976. Right whale feeding and baleen rattle. Journal of Mammalogy. 57(1):58-66.

Observations of surface and subsurface feeding behavior of right whales near Cape Cod since 1956 are described. During surface and subsurface feeding, right whales appear to". . . follow discreet rows of concentrated plankton. . ." but "no purposeful underwater sounds are heard during feeding. . ." The rattle of baleen is often heard during surface feeding. . . . and appears to be an adventitious sound". There are approximately 250 laminae of baleen per side. During feeding, right whale respiration averages one period of two to six blows, four to six minutes apart. No sounds suggestive of echolocation are noted although the authors report they have had ". . . many opportunities to record them under ideal listening conditions. . ." using equipment with band widths to 150 Khz.

Winn, H. E., H. L. Bischoff and A. G. Tarusk. 1973. Cytological sexing of cetacea. Marine Biology. 23(4):343-346.

Procedure for determination of sex by staining and locating sex chromatin bodies in the nuclei of female skin cells is described. A biopsy dart fired from crossbow or gun was developed to obtain necessary skin samples.

Wyrick, R. E. 1954. Observations on the movement of the Pacific gray whale, *Eschrichtius glaucus* (Cope). Journal of Mammalogy. 35(4): 596-598.

Average speed of migrating gray whales from four periods of observation ranging between 40 to 160 minutes in duration was 4.6 knots. Breathing cycle ". . . 'was ordinarily between 4 and 5 minutes", and consisted of three quick blows followed by a long dive. The detonation of one-half pound of tetryl-TNT within 500 yards of a whale caused the subject to maneuver ". . . so radically that it was not sighted again".

Yablokov, A. V., V. M. Bel'kovich and V. I. Bonsov. 1971. Whales and dolphins. Translation of Russian language book by Joint Publications Research Service, Arlington, Virginia, 1974. 2 vols.

Reports on the physiology, adaptive behavior, food preferences, review of systematic, origins and schemata for taking field notes on cetaceans.

LOGISTICS, SYNTHESIS AND DATA MANAGEMENT (RU 878)

INVESTIGATORS

John J. Kelley, Ph.D.

Gary A. Laursen, Ph.D.

STATEMENT OF TASK

This research unit provides for the management of PROJECT WHALES.

PURPOSE

Primary responsibility is to respond to the contractual needs of the BLM Outer Continental Shelf Office. Also, to coordinate all research efforts to meet project objectives.

RESULTS

Several research unit meetings were arranged with BLM in Anchorage and at Barrow to brief the Contract Officer's Representative and scientific office on progress and program direction, and to supply them with interim project information relative to their needs.

APPENDIX A

Analysis of Acoustical

Tapes from Pingok Island,

14 September - 7 October 1978

MEMORANDUM

Ser. *512/60*
8 Feb. 79

From: P. O. Thompson, Code 512

To: D. K. Ljungblad, Code 5131

Subj : Source of Pingok Island sounds; identification of

Ref: (a) Fonecon btwn DKLjungblad (NOSC) and PO Thompson (NOSC) January 1979

(b) Audio cassette tapes received 1 Feb. 1979

1. Preparatory to dealing with the Pingok Island tape, I listened to the fall and winter Pt. Barrow bowhead recordings.

2. As a result of subsequent listening to the Pingok Island tape, my opinions of the biologic sounds on this tape are as follows:

a. None of these sounds. are very much like the bowhead whale sound found on the other cassette.

b. Evidence that none of the sounds were from bowheads is strengthened by my observation that they were very much like the sounds I have heard from right whales, the whales that are essentially the same as the bowhead in most respects and whose sounds are very similar. Furthermore, none were very much like sounds I have heard from gray whales, whose range extends almost to Pingok Island.

c. In the latter part of the recording are some sounds made up of narrow-band pulses, sort of a gargling sound similar to sounds made by humpback whales. Other sounds in the recording sound like some of the high-pitched cry sounds in humpback whale song. However, humpback whales never are found north of Pt. Hope and are not known to sing in northern attitudes.

d. Some sounds on this cassette resemble even more sounds that were recorded in the Bering Strait by the Arctic Submarine Laboratory (NOSC) in the early 70's and described by me at the last meeting of the Acoustical Society of America (Dec. 1978). These sounds were from unidentified sources.

e. Some sounds on this cassette have the same quality as the underwater sounds of bearded seals and ringed seals, and others are like growling, roaring, or bellowing sounds made by pinnipeds with heads (or bodies) out of water.

f. None of the sounds in the Pingok Island recording resemble any we have heard from killer whales, beluga, or narwhal, the only small whales found in Arctic regions. As far as I know, no porpoises are close to this area at this time of year, and they are not known to make sounds at all similar to those of this recording.

g. As a summary of my opinion, I would conclude that none of the sounds in the Pingok Island recording were made by the bowhead whale or any other whale; but since many of the sounds are similar to sounds made by bearded and ringed seals, the most probable sound sources are whatever pinnipeds are in the area. I didn't notice any sounds I associate particularly with walrus, but I wouldn't altogether rule out walrus as the source of some of the sounds.

/s/ P. O. THOMPSON

Bioacoustics: RU-178
Fall Migration

The following is a summary of the (overall) frequency content of the 1978 Bowhead whale sounds at Pingok Island. The actual sonograms are not included but are archived. The sounds are believed to be pinnipeds. The analysis of these sounds is still in progress.

LJUNGBLAD FALL BOWHEAD

			Main Freq. Comp. (Hz)	Duration (See)	Frequency Inflec.	Verbal Description
1.	019	*B	55-170	0.5	none	Moan
2.	020	B	160-160	1.1	none	Moan (2nd & 3rd harmon. but p. wk)
3.	021	B	80-170	0.6	up	Moan
4.	026	B	50-100	0.65	up&dn	Moan
5.	041	B	100-150	0.5	down	Moan
6a.	044	B	10-80			
b.	044	B	70-450	0.8	dn&up	Moan with
7.	045	P	100-200	0.25	up	Moan
8.	047	B	70-160	1.5	down	Moan
9.	050	B	50-220	0.8	none	Grunt moan (3 or more comp) with pulse on end.
10.	050	P	260-310	0.75	down	Double bellow moan
11.	050	B	120-300	1.25	down	bellow belch
12.	051	P	410-510	0.35	none	Trumpet bellow
13.	051	B	90-400	1.5	dn&up	Moan
14.	052	B	90-210	1.5	down	Moan
15.	053	P	210-480	0.9	none	Roar
16.	054	P	400-1200	1.5	dn&up	Trumpeting (elephant)
17.	055	B	60-420	0.9	up	Double moan
18.	056	P	275-470	1.4	none	Wavering bellow
19.	058	P	100-400	1.65	dn&up	Double bellow moan
20.	059	B	90-140	0.8	dn&up	Double moan
21.	059	P	100-400	0.6	dn&up	Moan
22.	060	B	90-270	0.8	wn	Moan
23.	060	P	120-300	1.0	none	Moan with up chip on end
24.	061	P	130-130	1.0	none	Moan
25.	062	P	290-310	0.7	up& dn	Moan-cry
26.	164	P	115-850	1.7	down	Roar
27.	064	P	420-600	0.9	none	Roar
28.	064	P	130-360	1.6	up &dn	Moan-cry
29.	066	P	160-850	1.3	up	Cry
30.	066	P	270-850	2.1	up& dn	cry
31.	067	B	100-610	1.5	dn&up	Moan
32.	067	P	400-820	1.0	down	Cry
33.	139, 153, 159, 163, 168, 187, 191					
	B B B B B B P					
34.	139	B	70-180	1.5	up at end	Moan with harmonics
35.	153	B	35-210	1.5	up at end	Moan with harmonics
36.	159	B	40-300	1.3	up at end	Moan with harmonics
37.	163	B	35-300	1.4	up at end	Moan with harmonics
38.	168	B	35-260	1.6	up at end	Moan with harmonics
39.	187	B	80-200	1.5	essent. none	Moan, one harmonic

B = Bowhead, P = Pinniped

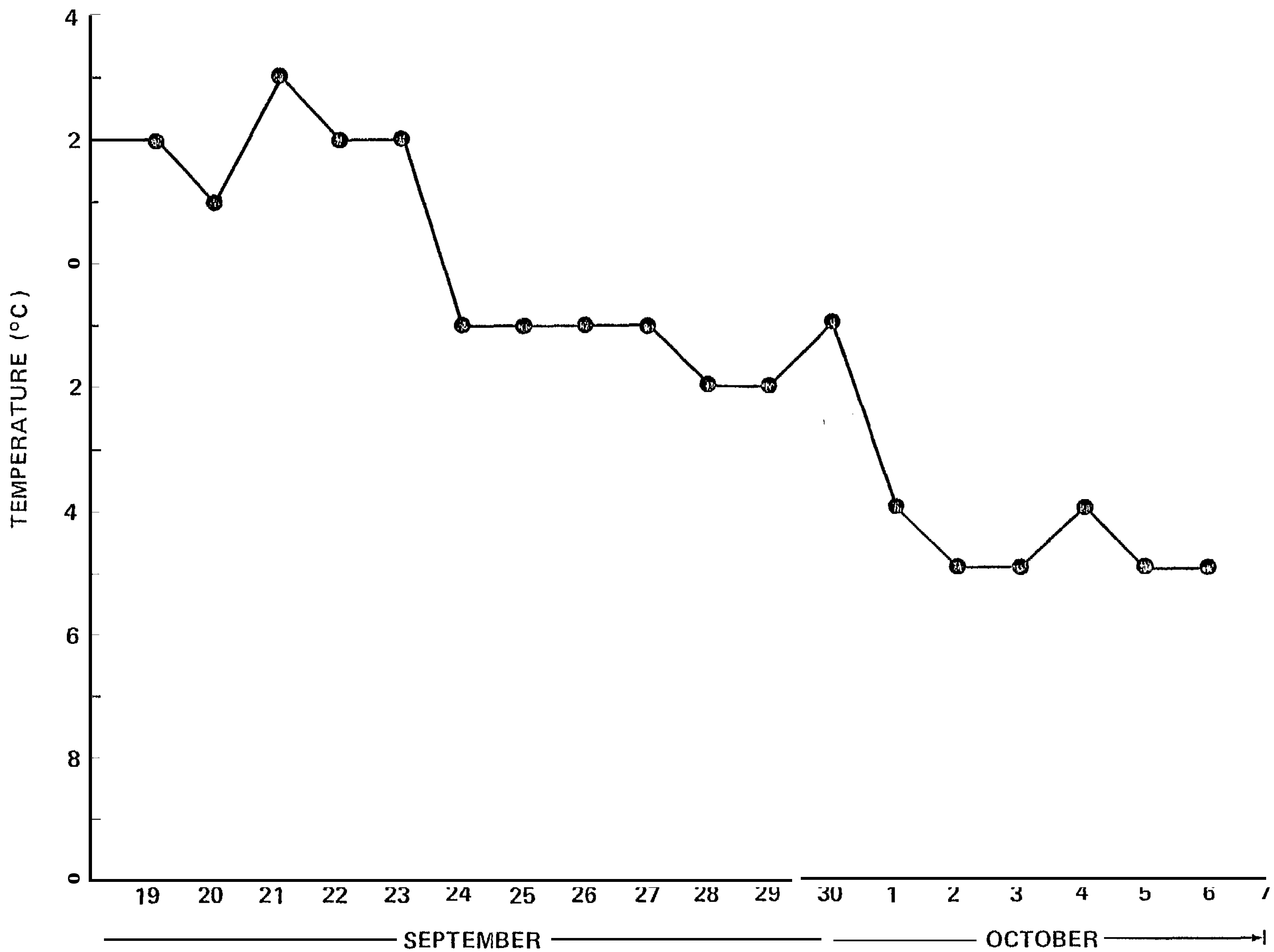
This fall recording was pretty hard to work with. It had so much A/C noise in the lows and it seemed to have less bandwidth in the highs. The whale sounds averaged lower in frequency and I had the impression that this was caused by individual difference -- that the main source in the fall recording was a very mature bull with a very deep “voice”.

Main Frequency Range (Hz) of Fall Bowhead

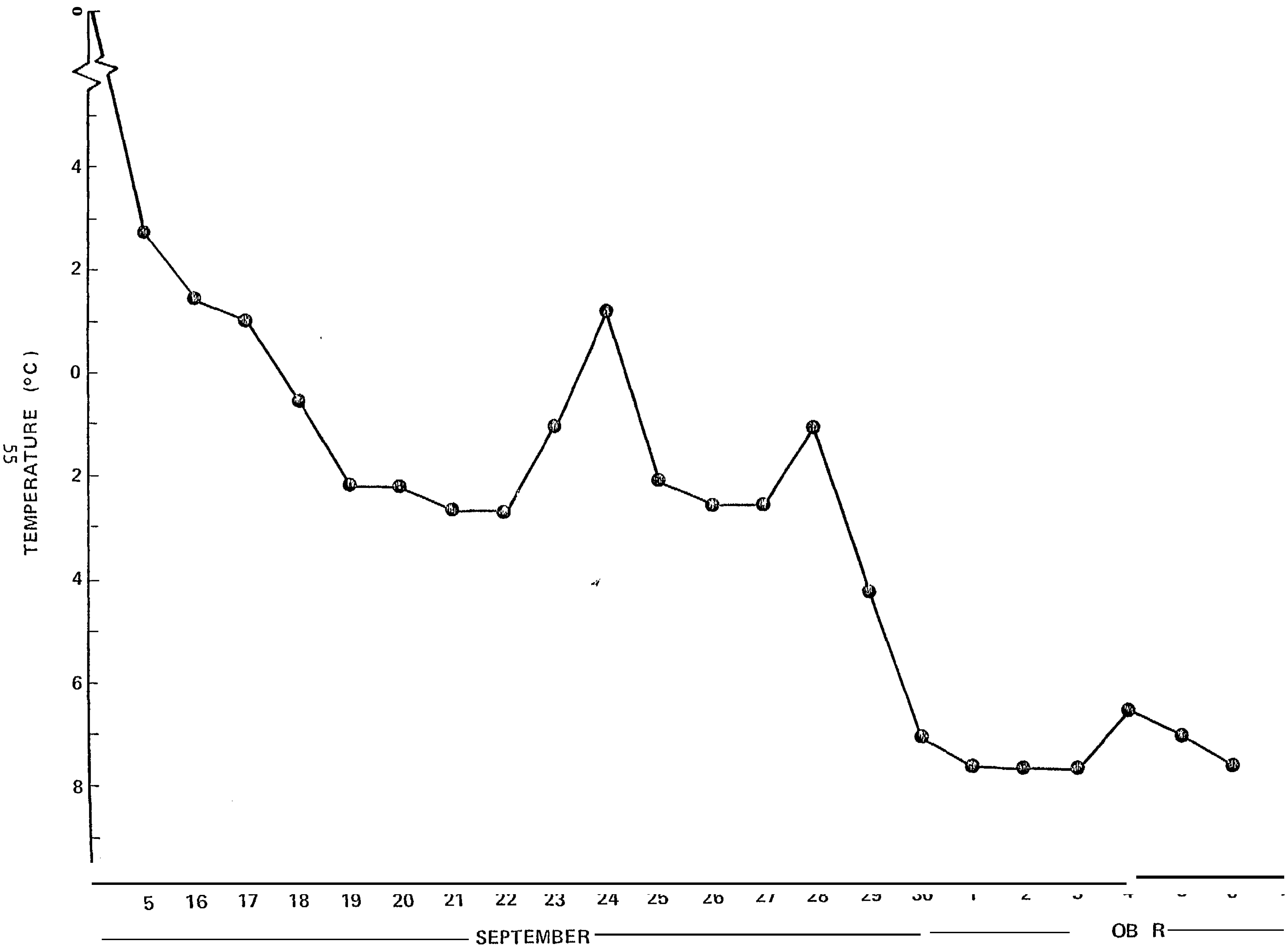
Selecting sounds that seemed almost certainly from Bowhead whales and rejecting those of less certainty.

	7	55	7	170
	22	160	5	160
	13	80	8	170
	6	50	2	100
	19	100	4	150
	8	60	1	80
	11	70	21	450
?	Man			
	12	70	6	160
	5	50	13	270
	21	120	16	300
	19	90	19	400
	16	90	11	210 Median
	9	60	20	420
	17	90	3	140
	18	90	15	270
	20	100	22	610
	10	70	9	180
	3	35	12	210
	4	40	17	300
	2	35	18	300
	1	35	14	260
	14	80	10	200

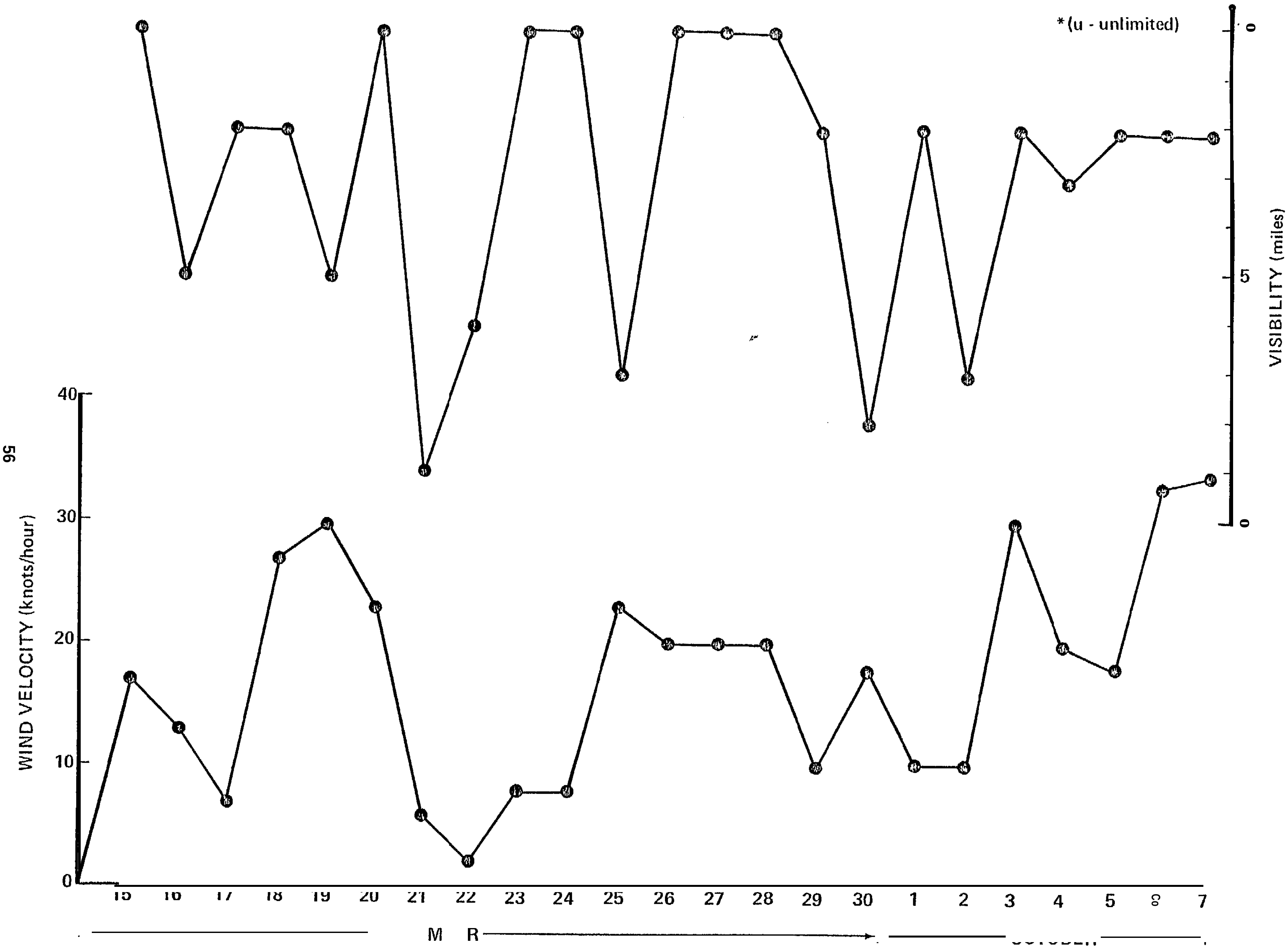
DAILY WATER TEMPERATURE °C MEASURED AT PINGOK ISLAND, 1978



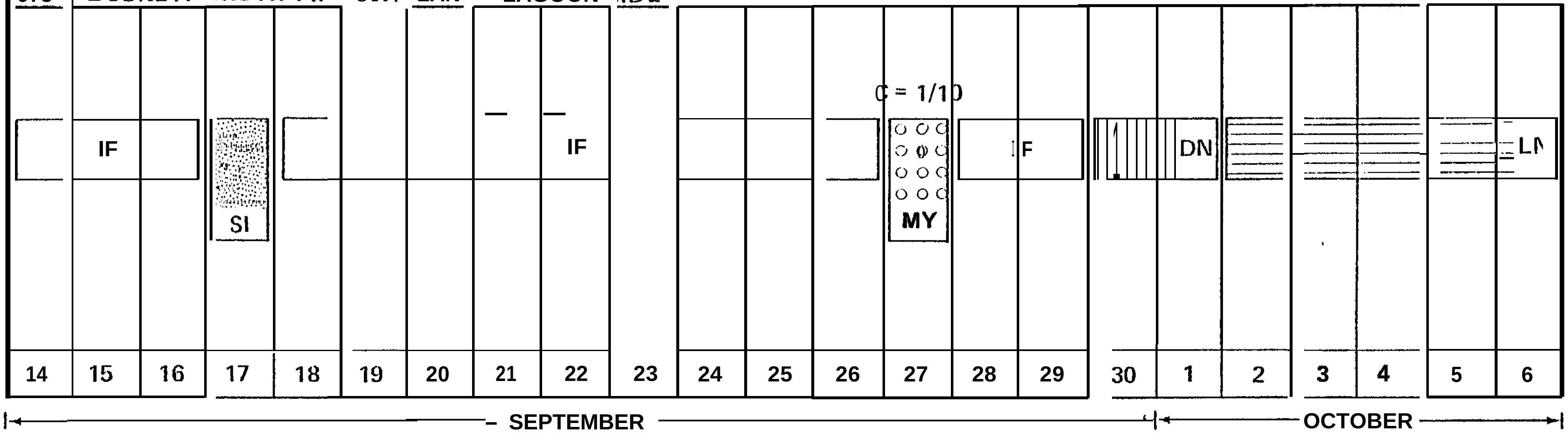
DAILY AIR TEMPERATURE (°C) MEASURED AT PINGOK ISLAND, 1978.



WIND VELOCITY (knots/hour) and VISIBIL TY (miles) MEASURED AT PINGOK ISLAND, 1979



1978 ICE CONDITIONS AT PINGOK ISLAND - LAGOON SIDE



Slush Ice

DN Dark Nilas under 5cm, dark color

LN Light Nilas over 5cm, light color

MY Small chunks multi-year ice 3m+ thick, has survived two summers melt

IF = Ice Free

SI = Slush Ice

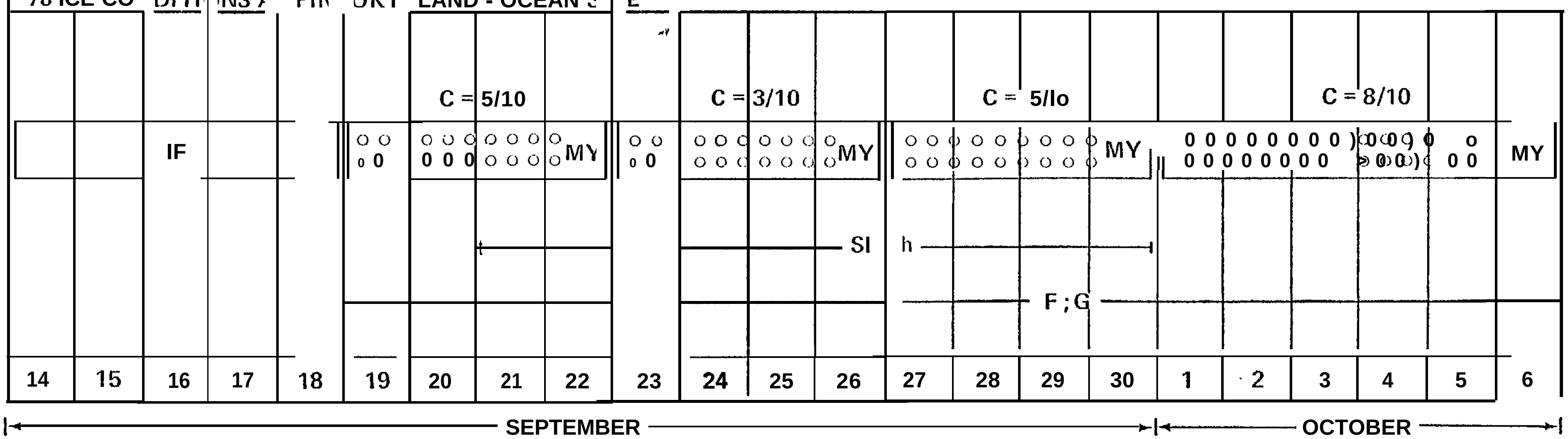
Sh = Shuga - spongy white ice lumps

F = Shore fast ice

GI = Grounded ice

C = Concentration, expressed in tenths, describing the mean areal coverage of ice in a given area

1978 ICE CONDITIONS AT PINGOK ISLAND - OCEAN SIDE



APPENDIX B

Environmental Data

Collected at Pingok Island,

14 September - 7 October 1978

APPENDIX C

Publications and Reports

Resulting from PROJECT WHALES'

Activities during Fall, 1978

HEALED PENETRATING INJURY OF THE BOWHEAD WHALE, _BALAENA MYSTICETUS_

Thomas F. Albert

George Migaki

Harold W. Casey

L. Michael Philo

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Dr. Migaki is Chief Pathologist, Registry of Comparative Pathology, Armed Forces Institute of Pathology, Washington, D.C. 20306

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Dr. Philo is Research Veterinarian at the Animal Research Facility, Naval Arctic Research Laboratory, Barrow, Alaska 99723

The bowhead whale has been successfully hunted by the Eskimo of arctic Alaska for centuries. In recent years increasing concern has been expressed over the rising number of animals taken and the rising number that are struck and lost (Marquette, 1977). The fate of those that are struck and lost is not known, however it is reasonable to assume that many succumb to their wounds.

Described herein is an instance of a bowhead whale evidencing a healed penetrating injury. Although positive proof is lacking, it is not unreasonable to propose that the penetration was due either to a harpoon or a shoulder gun fired bomb. The whale was taken during the fall 1978 whaling season in the Beaufort Sea off Kaktovik, Barter Island on the north eastern cease of arctic Alaska. The animal was struck on 15 September 1978 and lost in an approaching storm. On 21 September, with aircraft support, the animal was found floating approximately 28 km to the west and 4 km from shore. The whalers then beached the animal at that point.

The animal was a male, approximately 10.6 m in length and has been designated as whale #78KK1 by the National Marine Fisheries Service. As the butchering proceeded large sections (approximately 0.9 m X 0.6 m X 0.2 m) of skin with underlying blubber were removed and placed upon the beach. During collection of tissue specimens, what appeared to be a scar was noted extending from the skin and through the blubber on one of the sections lying on the beach. The area of suspected scar tissue was a whitish tract which extended through the blubber at an angle, was 2.5 cm in diameter, 11 cm long and firmer than the surrounding blubber (Figure 1). The whitish tract was continuous externally with an area of white skin, slightly depressed from the surrounding black skin. This locus of white skin was somewhat irregular in shape, approximately 2.5 cm long, 1 cm wide and 0.8 cm thick. Since the suspected scar was noticed in tissue removed from the animal it was neither

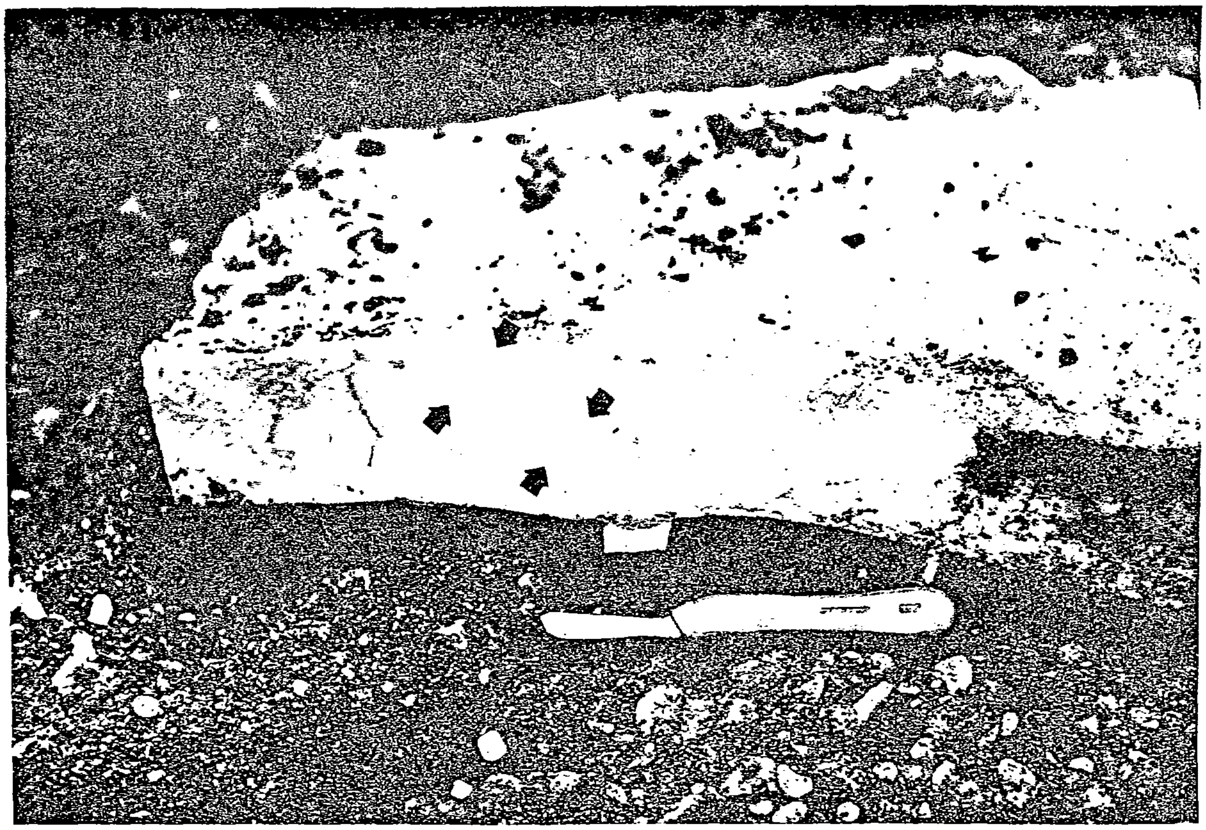

Fig. 1 Large section of skin with attached blubber lying on beach. Note locus of white epidermus with scar tissue (arrows) extending through blubber.

possible to localize its position upon the animal nor to determine the full extent of the penetration. This and other materials were placed into 10% buffered formalin and prepared for histological examination.

HISTOLOGICAL FINDINGS AND DISCUSSION

The epidermis of cetaceans is divided into 3 separate layers or strata (Harrison, 1974). The stratum germinativum or the basal cell layer forms the junction between the dermis and epidermis and is composed of columnar type epithelial cells and melanocytes containing brownish-black melanin pigments. The presence of these pigments accounts for the black appearance of the skin. The stratum externus or the other cell layer is composed of flattened cells each containing an elongated nucleus. Since all of the cells in the epidermis contain a nucleus, no true stratum corneum is recognized.

The normal skin of this bowhead whale was composed of a thick epidermis and a relatively thin dermis which merged with a thick underlying hypodermic or blubber. The epidermis was black and about 18 mm thick. The rete ridges were uniform in size and shape and extended deep into the dermis. The dermal papillae containing small blood vessels were found more than half way up the epidermis (Figure 2). The dermal papillae were comparatively wide and this would account for the visible parallel vertical lines which result in the striated appearance of the epidermis on cut surface (Figure 3).

The dermis measured about 3 mm in thickness and was composed almost entirely of collagenous fibers with lesser amounts of elastic fibers. The dermis was divided into an outer papillary layer containing the dermal

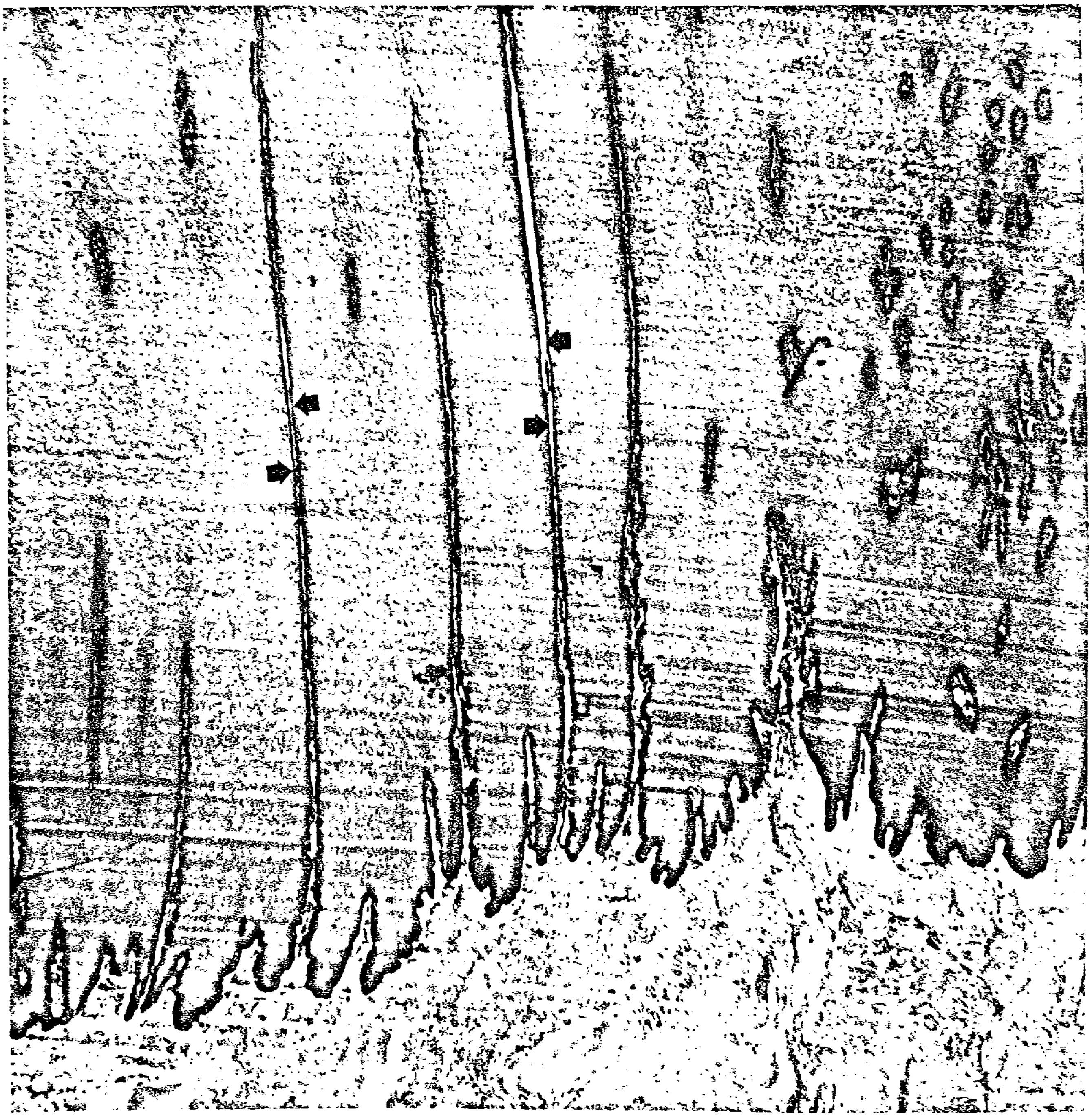

Fig. 2 Photomicrograph of skin with epidermis above and dermis below. Note dermal papillae (arrows) extending well into the epidermus.
H + E; X 11.

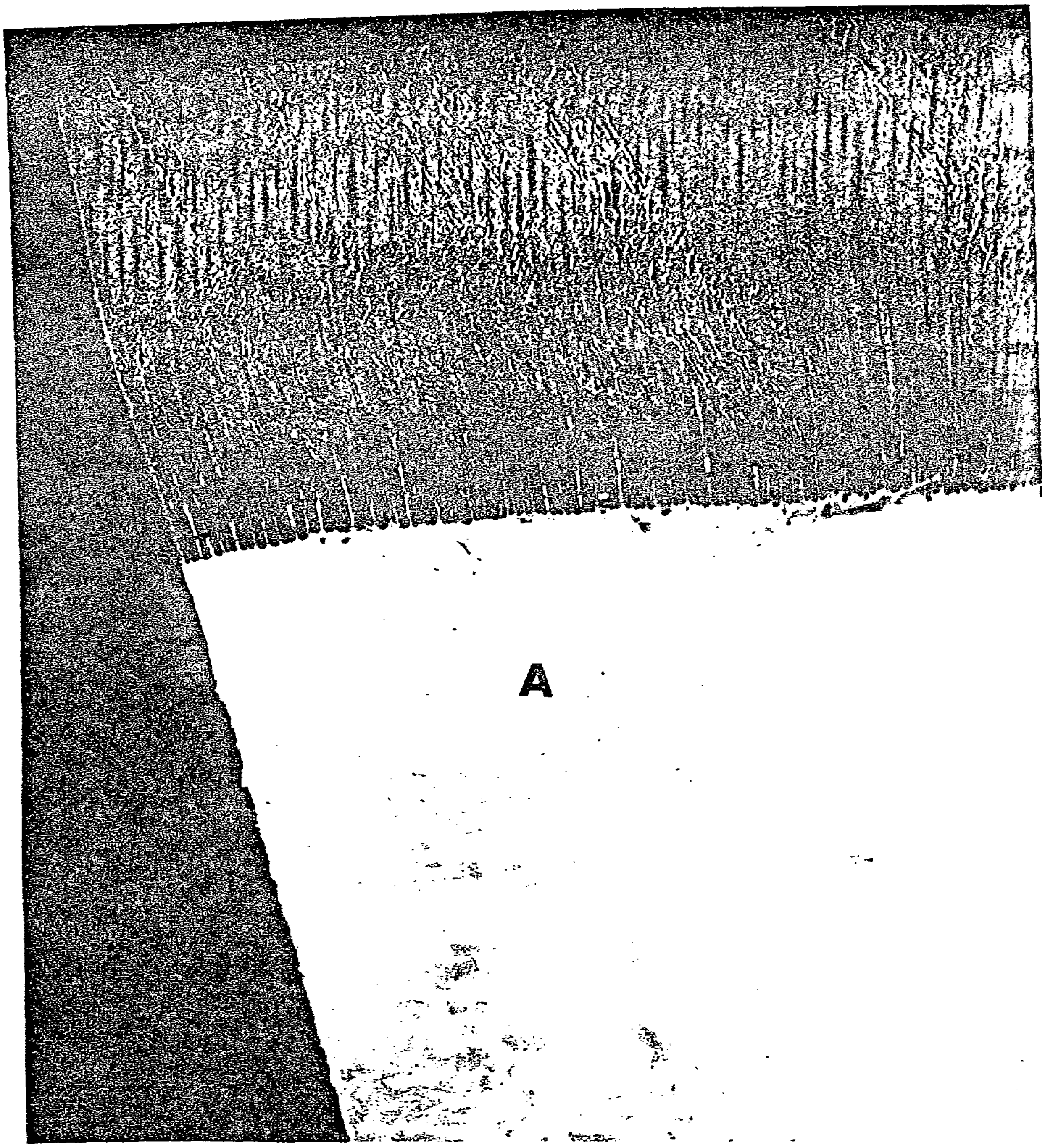

Fig. 3 Cut surface of skin with underlying blubber (A). Note vertical striations in black epidermus due to dermal papillae.

papillae and an inner reticular layer which merged with the hypodermic. The fibers were arranged in bundles of uniform size and could be found extending in different directions especially in the reticular layer. Blood and lymph vessels as well as nerve bundles were evident.

The blubber was continuous with the dermis and was composed almost entirely of mature fat cells which were supported by thin bundles of collagenous fibers.

Histologically, some differences were noted between the white epidermis external to the fibrous tract and the adjacent black epidermis (Figure 4). In this white epidermis, the cells did not contain melanin pigments and the rete ridges were very irregular in shape and appeared to be much wider and shorter (Figure 5) than those of the black epidermis (Figure 6). In the dermis beneath the white epidermis, the whitish tract was composed of mature collagenous fibers arranged haphazardly and in smaller bundles (Figure 7) than those seen in the normal dermis (Figure 8), Evidence of granulation tissue was lacking and occasional foci of mononuclear leukocytic infiltrate were noted (Figure 9). In the blubber the whitish tract was composed of mature collagenous fibers arranged in bundles which were oriented in many different directions (Figure 10).

The fact that the animal's skin was in contact with near freezing water undoubtedly contributed to the maintenance of the skin's histological structure following death.

The morphology of the white epidermis and the discrete whitish masses in the dermis and blubber are suggestive of repair following a deep penetrating traumatic wound. The presence of mature collagenous tissue with

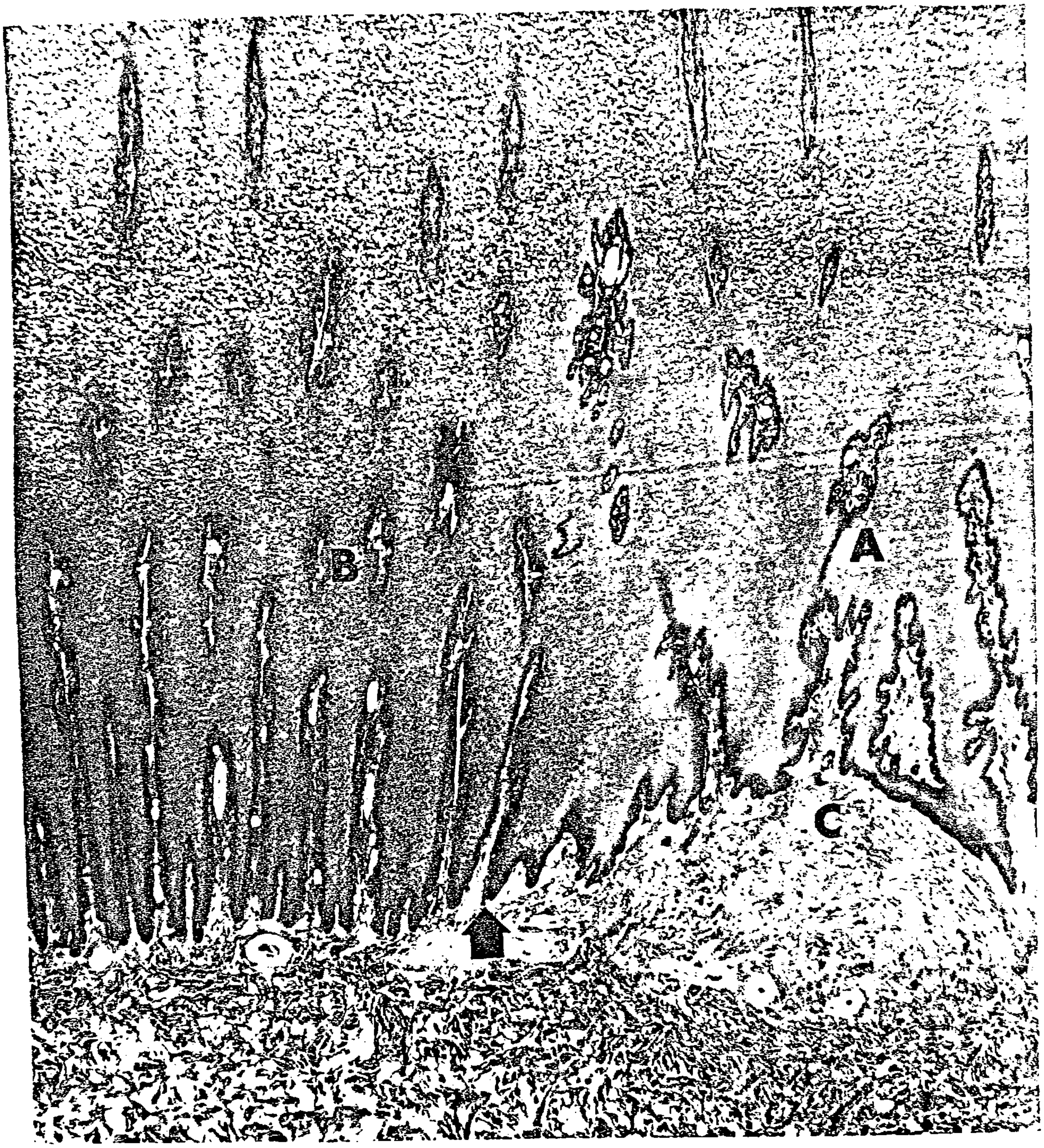

Fig. 4. Photomicrograph of skin at the junction (arrow) between white epidermis (A) and black epidermis (B) . Note discrete areas of fibrosis in the dermis (C).
H + E: X 11.

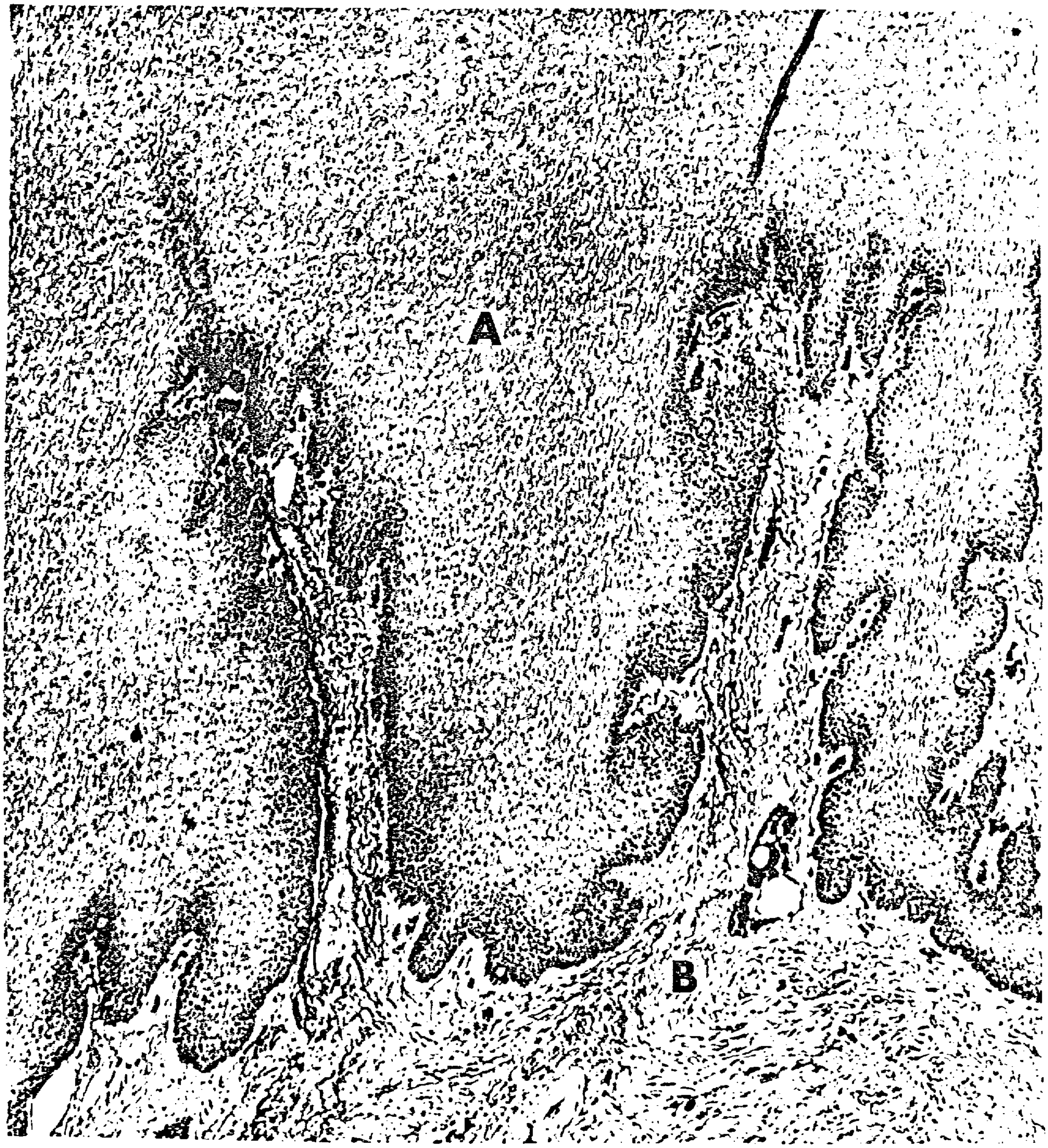

Fig. 5. Photomicrograph of the white epidermis (A) . Note the absence of melanin pigment, and the irregularly shaped and short blunt appearance of the rete ridges entending into the dermis (B) below when compared to the normal black epidermis in Figure 6.
H + E; X 45.

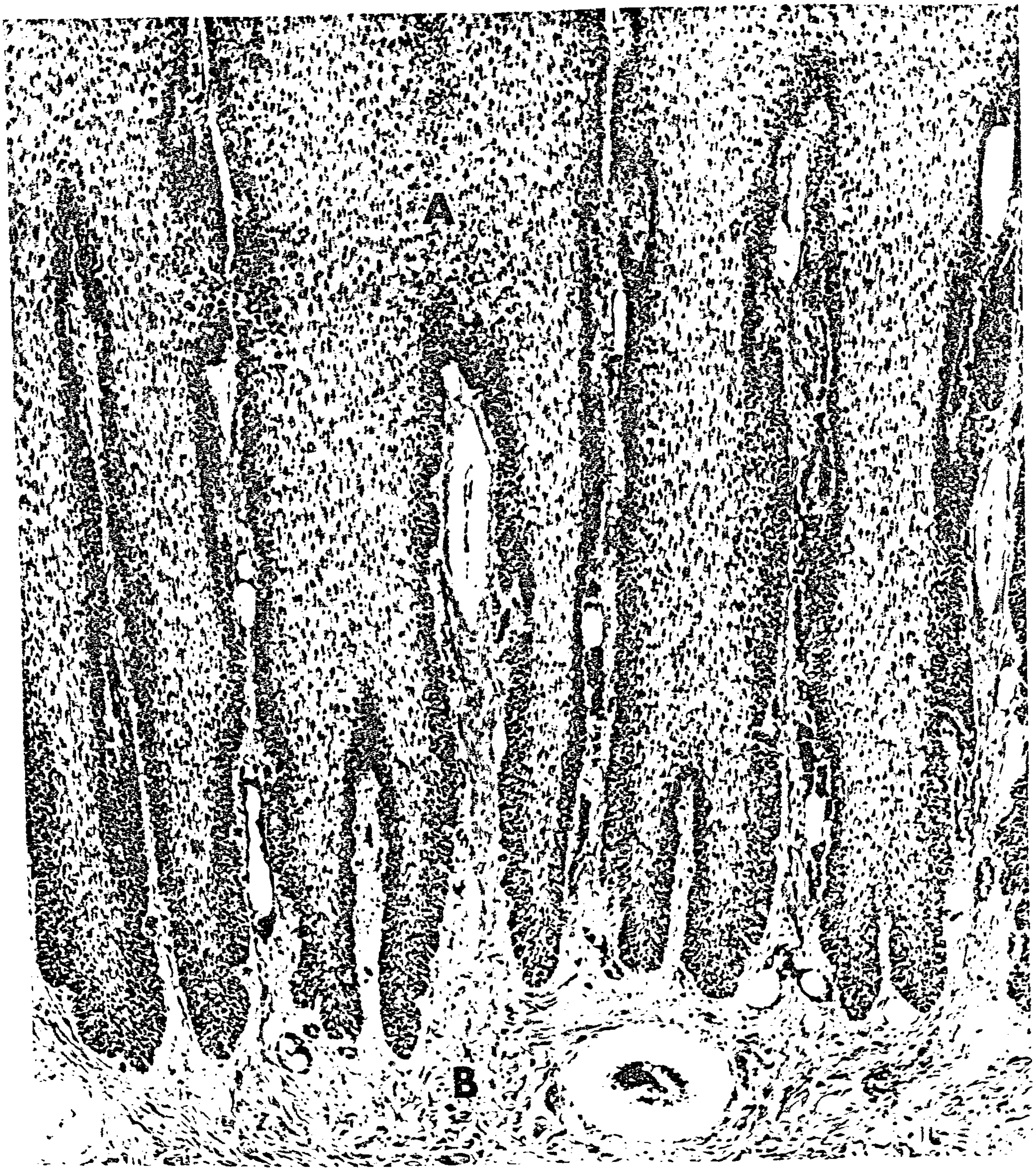

Fig. 6. For comparison with Figure 5. Photomicrograph of the normal black epidermis (A) . Note the presence of melanin pigments and the uniform size and shape of the rete ridges extending into the dermis (B) below.
H + E; X 45.

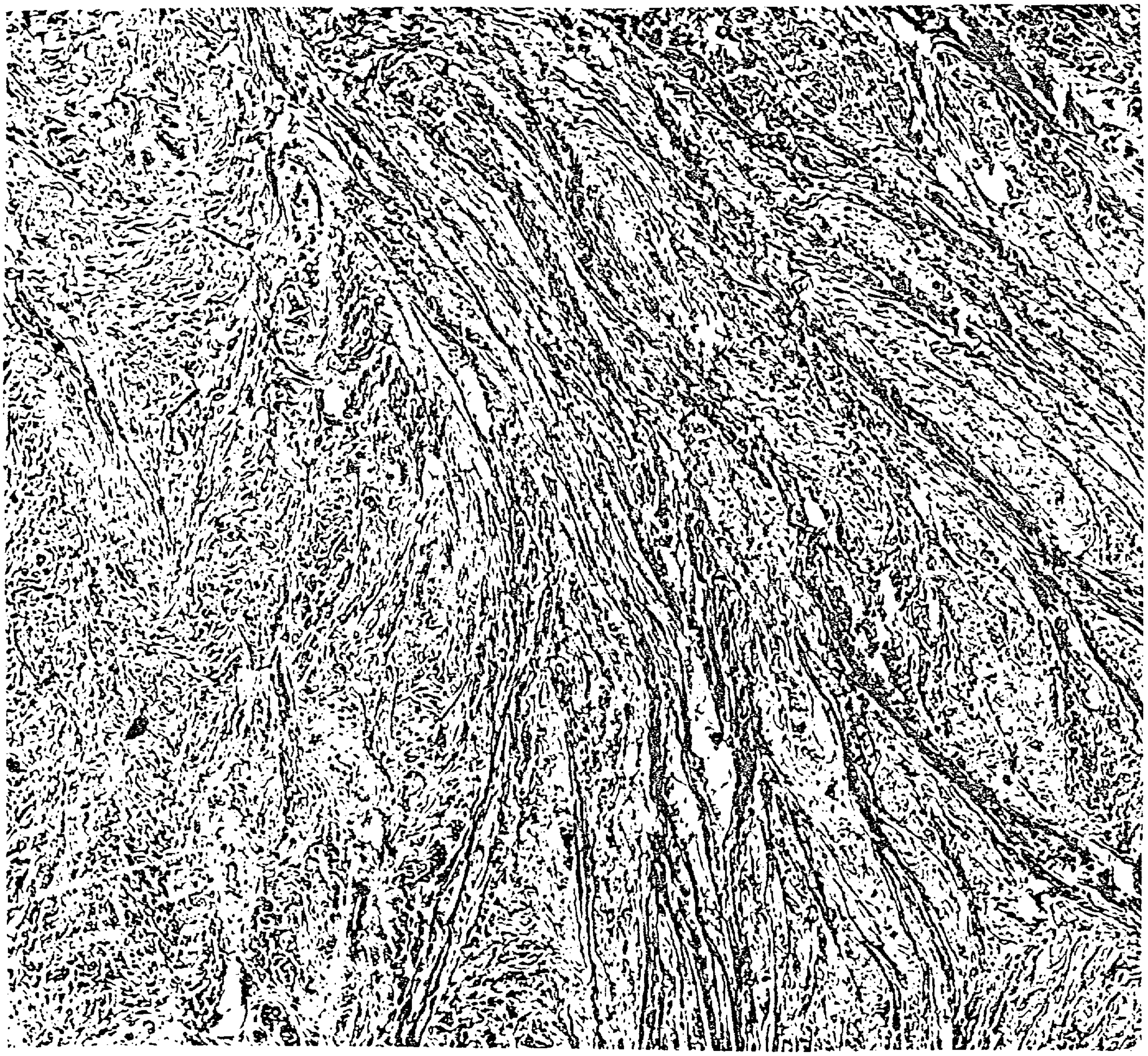

Fig. 7. Photomicrograph of the whitish tract in the dermis and blubber. Note the haphazard arrangement of the collagenous fibers which appear to be in samller bundles than those found in the normal dermis (see Figure 8) .
Mason trichrome; X 45.

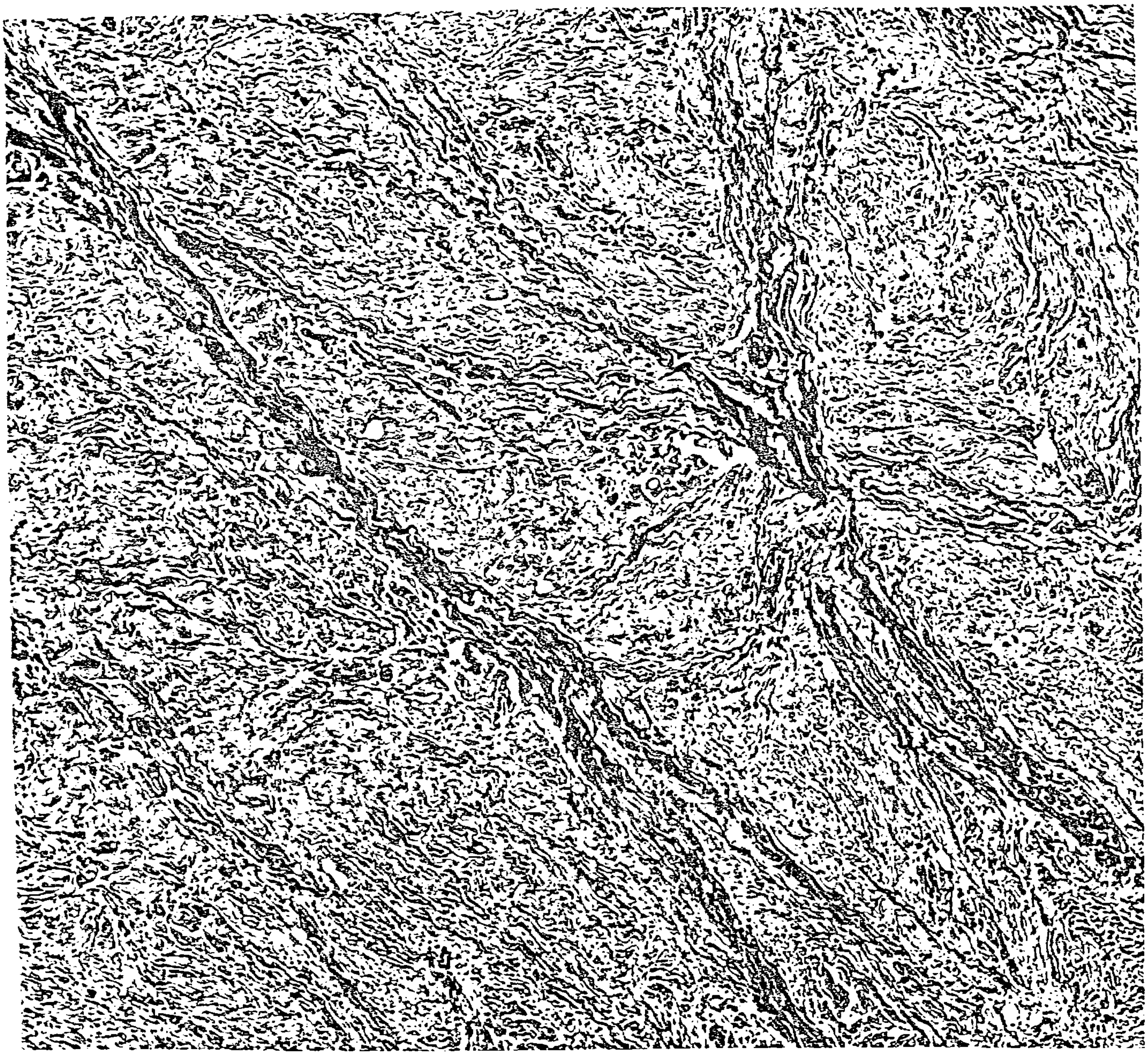

Fig. 8. For comparison with Figure 7. Photomicrograph of the normal dermis. Note the uniform size and appearance of the bundles of collagenous fibers.
Mason trichrome; X 45.

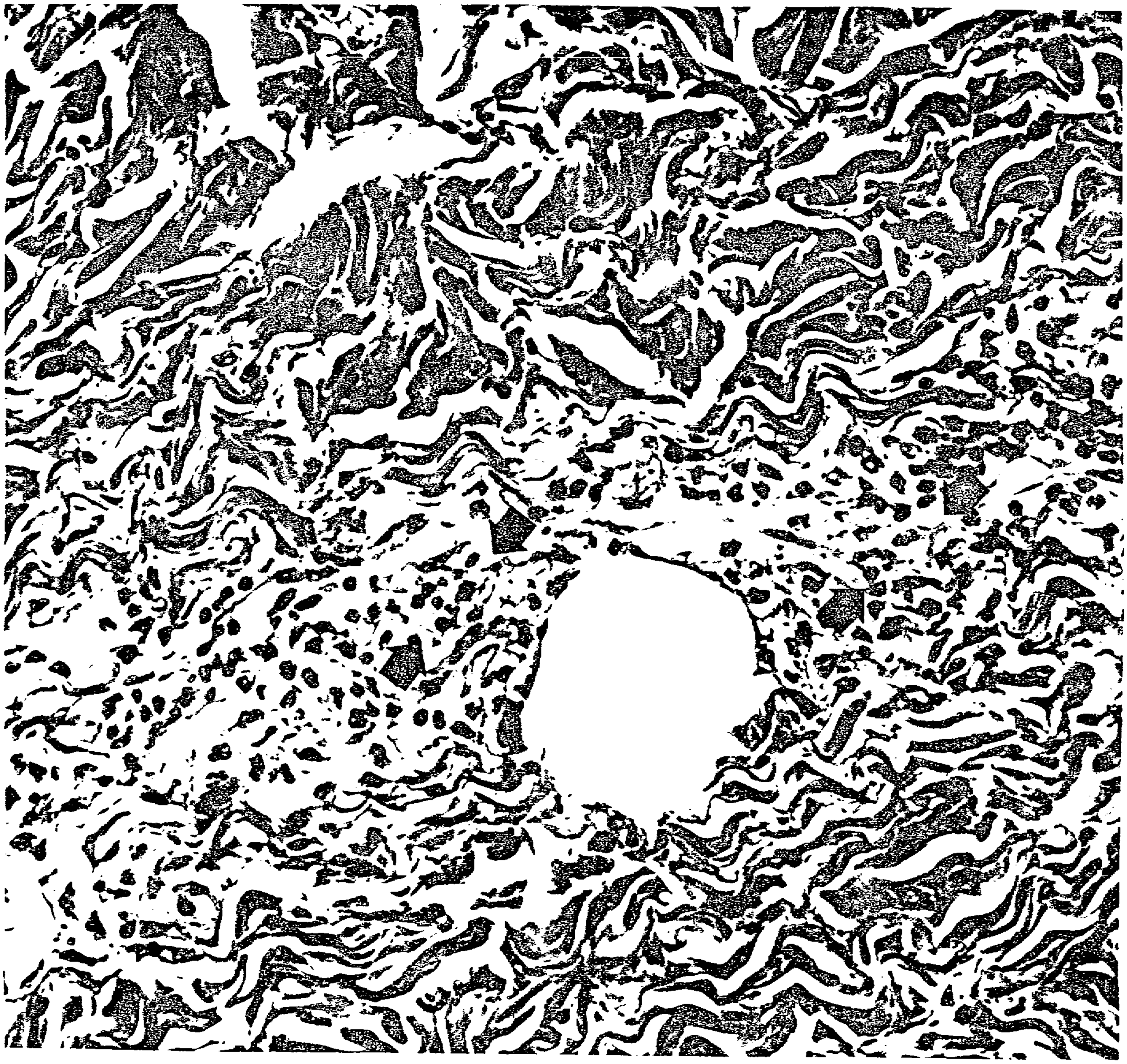

Fig. 9. Photomicrograph of the dermis beneath the white epidermis showing small foci (arrows) of lymphocytes and plasma cells.
Mason trichrome; X228.

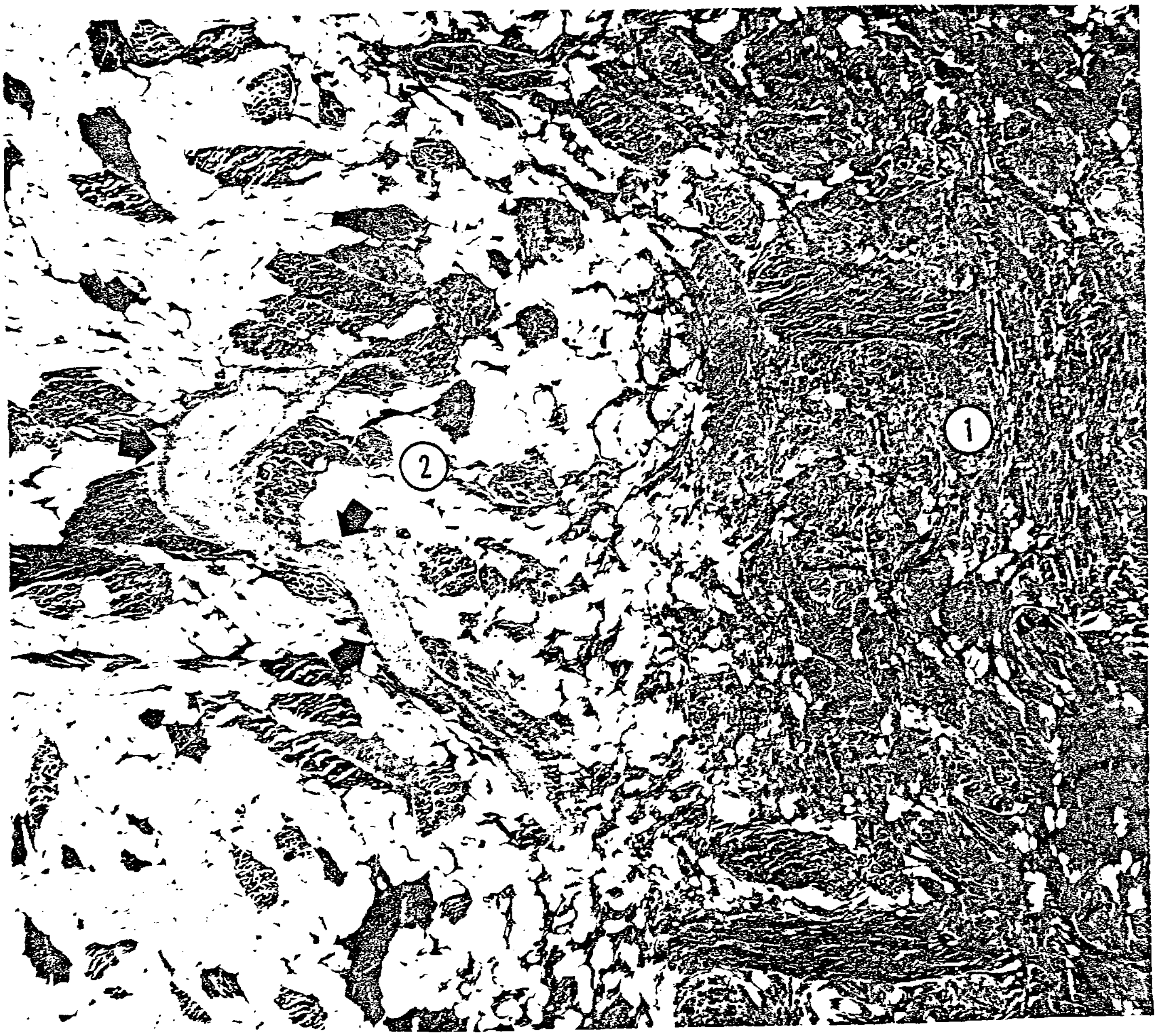

Fig. 10. Photomicrograph of the whitish tract (1) passing through the blubber (2). The whitish tract is composed almost entirely of mature collagenous fibers arranged in bundles. The blubber is largely composed of mature fat cells supported by thin bundles of collagenous fibers. Note the blood vessel (arrows) .
H + E; X 11.

little or no leukocytic response and the absence of vascularity are indicative of a chronic lesion of long duration. It is apparent that melanocytes were destroyed in the injured epidermis and that regeneration was accomplished by epithelial cells, thus resulting in a white epidermis.

White scars on the skin of cetaceans have been reported as resulting from various causes (Greenwood, Harrison and Whitting, 1974; Harrison and Thurley, 1974; McCann, 1974). These include mechanical pressure necrosis of the skin resulting from non-aquatic transportation, intraspecific fighting, attack by the sea lamprey, trauma due to contact with ice floes, and freeze branding. It has been noted however that the skin of cetaceans inhabiting cold northern waters is generally without scars (Yablokov, Belkovich, Borisov, 1972).

Penetrating injuries containing portions of the spear like snout of a sword fish (Machida, 1970) and marlin, Makaira Sp. (Ohsumi, 1973) have been noted in at least the sei whale, Balaenoptera borealis, and minke "whale, Balaenoptera acutorostrata.

In the present instance it is not likely that the penetrating injury was due to a billfish as their distribution (Klawe, 1977) does not overlap with what is suspected to be the southern limit of the bowhead whale's range. It would also seem unlikely that the wound was due to a pointed object that the animal encountered in the water during its travels. A reasonable explanation would seem that the animal had been struck by an Eskimo hunter during an earlier whaling season and survived the encounter.

As can be seen in Figure 11 the wound in the blubber caused by the passage of one of the bombs used to kill the animal is approximately the same diameter as that of the scar described above.

ACKNOWLEDGEMENT

The complete cooperation of Herman Aishanna, Kaktovik, Alaska in the collection of tissues from this whale is appreciated. This investigation was supported in part by Bureau of Land Management Contract No. 38083, by Office of Naval Research Contract No. NOOO14-76-C-1059, and by Public Health Service Grant No. RR0301-13 from the division of Research Resources, NIH, DHEW, under the auspices of Universities Associated for Research and Education in Pathology, Inc.

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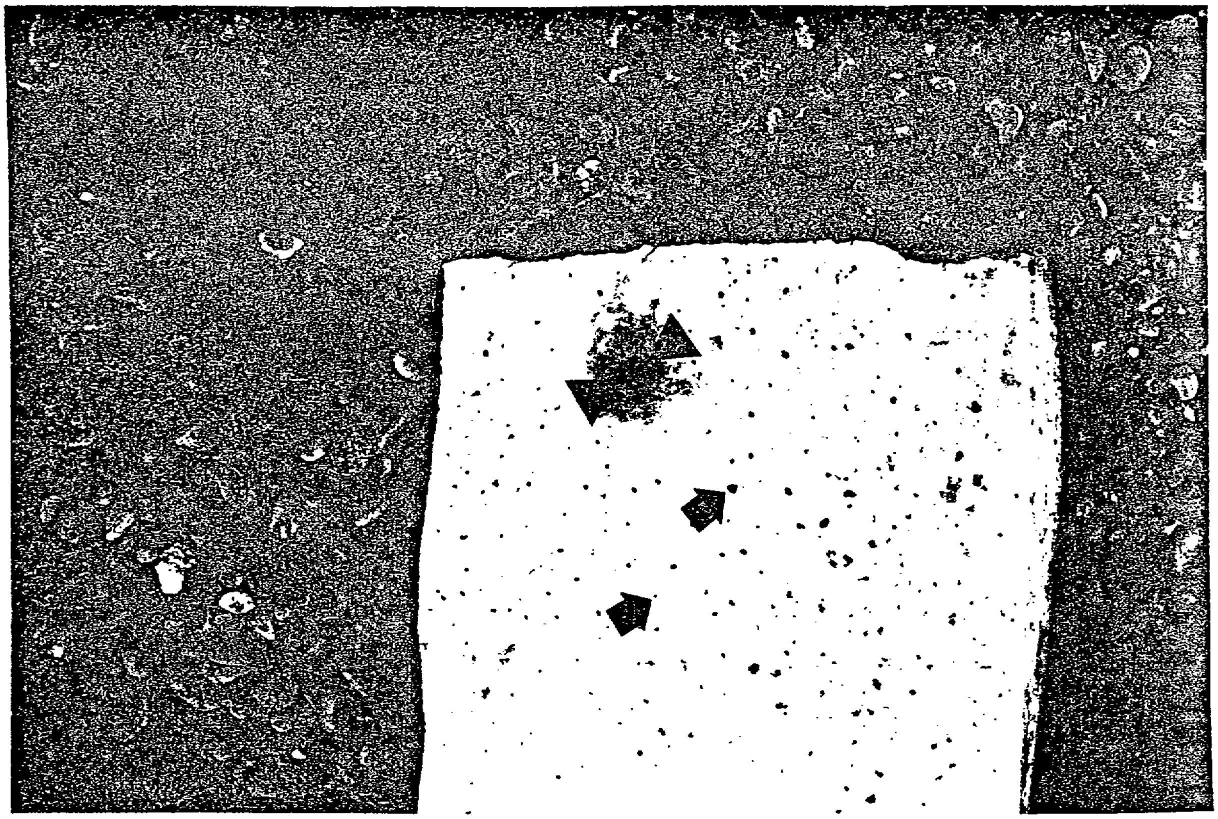

Fig. 11. Large piece of blubber lying on beach. Note fresh wound (closed triangles) caused by passage of one of the bombs used the kill the whale. Also apparent are numerous readily visible blood vessels (arrows) .

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